Supreme Court of the United States,

IN EQUITY.

THE STATE OF PENNSYLVANIA

VERSUS

THE WHEELING & BELMONT BRIDGE COMPANY.

COMPLAINANT'S BRIEF

OF THE

PLEADINGS AND EVIDENCE,

COMMISSIONER'S REPORT AND EXCEPTIONS.

PITTSBURGH:

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In the Supreme Court of the United States.

The State of Pennsylvania,
vs.
The Wheeling and Belmont Bridge Company, and others.

In Chancery.

THE PLEADINGS.

This cause comes on for final hearing upon the original and supplemental Bills, Answers, Replication, Exhibits, Testimony, Commissioner's Report, and Exceptions.

The original Bill, filed in July, 1849, charged that the defendants, under color of an Act of the Legislature of Virginia, but in direct violation of its terms, were engaged in the erection of a Suspension Bridge across the channel of the Ohio River, at Wheeling, which would obstruct the navigation of that river, to and from the ports of Pennsylvania, by steam boats and other craft commonly accustomed to navigate the same. That the State of Pennsylvania owns certain valuable public works, canals and rail-ways, constructed at great expense as channels of commerce, for the transportation of passengers and goods, from which she was accustomed to receive large tolls and revenue. That these works terminate on the Ohio River, and were constructed with direct reference to its free navigation. The goods and passengers transported on these works were accustomed to arrive and depart in steam boats, on the Ohio River; and the Wheeling Bridge would so obstruct the navigation of that river, as to cut off and divert trade and business from the public works of Pennsylvania, impair and diminish the tolls and revenue of the State, and render her improvements useless. The Bill prayed injunction against the erection of the Bridge as a public nuisance, and general relief.

In July, 1849, notice was given that an injunction would be applied for in vacation, before the Hon. R. C. Grier, one of the Justices of the Supreme Court, on the 10th day of August, 1849,—at which time a supplemental Bill was exhibited, setting forth that after notice the defendants

continued to prosecute their work, and were engaged in stretching iron cables across the channel of the river, which would obstruct its navigation. It prayed that these cables might be abated, and for relief, as in the original Bill.

The motion for injunction being referred by Mr. Justice Grier to the Supreme Court in Banc, at December Term, 1849, a supplemental Bill was then filed, setting forth that defendants had completed the erection of the Bridge, and that it had obstructed the passage of steam boats carrying freight and passengers to and from the ports of Pennsylvania. That it also hindered the passage of steam ships and sea-going vessels, which were accustomed to be built and constructed at the ports of Pennsylvania; and would injure and destroy the trade and business of ship and boat building which was accustomed to be carried on by her citizens at Pittsburgh. It prayed an abatement of the Bridge as a public nuisance, and for general relief.

The defendants, in their answers, allege the exclusive sovereignty of Virginia over the Ohio River, and set forth the Act authorizing the erection of the Bridge. The following grounds of objection to the application for injunction and the relief prayed for, were insisted on:—That the persons injured might have remedy in the Courts of Virginia. That the State of Pennsylvania had no corporate capacity to institute this suit in the Supreme Court to vindicate the rights of her citizens. That the State was only a nominal party, whose name was without proper authority used by individuals. That the Bridge is a connecting link of a great public highway, as important as the navigation of the Ohio River. That Pennsylvania had set the example of authorizing bridges across the Ohio. That certain Engineers of the United States had recommended a wire Suspension Bridge at Wheeling, and gave as their opinion, that "by an elevation of 90 feet every imaginable danger of obstructing the navigation would be avoided." That certain reports of committees in Congress recognised the necessity of a Bridge at Wheeling, and recommended an appropriation for that purpose. That the headway for steamers left by the Bridge is amply sufficient, 47 feet above the water being sufficient for all useful purposes—and if sufficient draft cannot be had at that height, blowers might be added. That chimneys might have hinges on them, so as to be lowered without much inconvenience. That the Bridge will not be an *appreciable* inconvenience to the *average* class of boats. That the Bridge will not diminish or destroy trade between Pittsburgh and other ports, or do irreparable injury to the citizens of Pennsylvania.

It is admitted in the Answer, page 434, that the State of Pennsylvania has expended large sums of money in the construction of public improvements, terminating at Pittsburgh and Beaver. That a great amount of

freight and a large number of passengers do pass over said works, and that a large amount of toll is derived therefrom, which finds its way into the treasury of the State. THAT THE NAVIGATION OF THE OHIO RIVER IS IMPORTANT TO THE WORKS ABOVE REFERRED TO, AND THAT THE VALUE THEREOF WOULD BE AFFECTED INJURIOUSLY, IF FROM ANY CAUSE THE PASSAGE OF STEAM BOATS FROM THE CITY OF PITTSBURGH DOWNWARDS WERE OBSTRUCTED OR IMPEDED. But they deny that their Bridge or the cables will have any such effect, or that it can in truth be called a nuisance.

To the actual obstructions occasioned by the Bridge, as charged in the second supplemental Bill, they set up an amendatory and explanatory Act of the Virginia Legislature, passed January 11, 1850, declaring the height of 90 feet at the eastern abutment, 93½ feet at the highest point, and 62 feet at the western abutment, above the low water level of the Ohio River, to be of *lawful height*, and in conformity with the intent and meaning of the 19th section of the Charter. To the complaint of those obstructions no other answer is made.

ORDER OF REFERENCE.

After argument at the December Term, 1849, the case was referred to the Hon. R. H. Walworth, as special Commissioner to take testimony and report—

1st. Whether the Bridge is or is not an obstruction of the free navigation of the Ohio River by vessels propelled by steam or sails, engaged or which may be engaged in the commerce or navigation of said river.

2d. If an obstruction be made to appear, what change or alteration in the construction and existing condition of the said Bridge, if any, can be made, consistent with the continuance of the same across said river, that will remove the obstruction to the free navigation.

COMMISSIONER'S REPORT.

At the December Term, 1850, the Commissioner submitted his Report, together with the Report of his Engineer and the proofs taken before him, deciding—

1. That the Bridge is not an obstruction to the free navigation of the Ohio by any vessels propelled by sails. *Walworth's Report*, 30.

2. That the Bridge is an obstruction of the free navigation of the Ohio by vessels propelled by steam. *Walworth's Report*, 45.

3. That the change or alteration which can and should be made in the construction and existing condition of the Bridge is, to raise the cables and

flooring in such manner as to give a level headway, at least 300 feet wide, over a convenient part of the channel, of not less than 120 feet above the level of zero on the Wheeling water gauge. But no provision is made for a greater amount of headway, should the future wants of trade and commerce on this part of the river require it. *Walworth's Report*, 53.

EXCEPTIONS.

The Complainant excepts—

1. To so much of the Report as finds that the Bridge is not an obstruction to vessels propelled by sails; and in the particular that it does not provide headway under the Bridge for ships and sea-going vessels, with their masts standing.

2. That 120 feet above the level of zero, is not adequate elevation to remove the obstruction to the passage of steam boats—145 feet being required; and the width of 300 feet level headway is also insufficient, no necessity being shown for any obstruction to navigation by a bridge at that point, and because no obstruction is authorized, nor could be by any State enactment.

3. That no provision is made for greater steam boat headway, if required, by the future wants of commerce on the river.

So far as the Report finds the Bridge to be an obstruction and requires elevation, the complainant asks its confirmation, and prays that the Bridge be entirely abated, or elevated to the height of 145 feet across the whole width of the channel.

The Defendants except—

1. That the Commissioner required the parties to appear before him at Wheeling, on the 11th of July, 1850, without application of either party, and immediately adjourned to an inconvenient place six miles from Wheeling.

2. That he has expressed opinions on the questions referred, without first taking all the proofs which defendants' Counsel saw fit to produce before him, deciding that he would not receive testimony which he considered irrelevant, and excluding testimony that was relevant.

3. That the Commissioner privately applied to the Court for an extension of time for his proceedings, and suffered defendants' Counsel to take their course in ignorance that such application had been made.

4. That the Commissioner argues to prove that wire suspension bridges are not adapted to rail roads.

5. That the Commissioner reports that the Bridge is an obstruction to navigation by steam vessels.

6. That the Commissioner reports the Bridge should be elevated to 120 feet above zero, so as to give a level headway 300 feet wide over the channel.

7. That the Commissioner decided on the assumption, that if steam boats can increase speed by tall chimneys, they are entitled to such benefit in opposition to the claims of all who require a bridge.

8. That the Commissioner refused to receive testimony showing the injury and inconvenience the public would suffer for want of a bridge, and received testimony showing the present and prospective importance of the commerce of the river; and while expressing an opinion favorable to the tallest chimneys, has omitted all reference to the testimony showing in what degree a reduction of their height would impair their utility, and what proportion of boats will use chimneys of the extreme height he considers useful.

9. That the Commissioner appointed Edwin F. Johnson, Engineer, to make measurements.

10. That the Commissioner unnecessarily increased the expenses under the order of reference.

11. That the Commissioner returned the Engineer's Report without an opportunity to the parties to inspect it before the testimony closed.

12. Besides the above exceptions, defendants insist on their exceptions taken before the Commissioner, and returned by him with the testimony.

EVIDENCE.

Under the order of reference, many witnesses were examined before the Commissioner at Pittsburgh, Wheeling, Cincinnati, Louisville, and New-York. The conclusions of the Commissioner upon the various points of inquiry, and the substance of the testimony, are stated under the following heads:

1. Regimen of the Ohio River.
2. What boats are best adapted for Ohio navigation.
3. Building of steam boats, ships, sea-going steamers, and vessels of war, on the Ohio.
4. Commerce of the Ohio River.
5. Commerce of the Pittsburgh and Cincinnati packets.
6. Description of the Wheeling Bridge.
7. The Wheeling bridge obstructs navigation.
8. That when the Bridge was planned, defendants knew it would obstruct navigation.
9. How the Bridge should be altered.
10. Necessity for high chimneys.
11. Steam boat fuel on the Ohio.
12. Natural draft by high chimneys, the best method of propelling steam boats.
13. Chimney draft depends upon its height, not upon the diameter or cubic capacity.

14. High chimneys required by the *limited* space on steam boats for boilers and fire surface.

15. Practical advantages of high chimneys.

16. Progressive increase in size of western boats, and their chimneys.

17. Progressive increase in the height of chimneys on eastern boats.

18. That the size of boats engaged in commerce on the Ohio River will continue to increase.

19. Height of chimneys on Ocean, Lake, and Eastern River steamers.

20. Height of Western packet chimneys before the erection of the Bridge.

21. Weight, size and cost of the packet chimneys.

22. Cost and inconvenience of the apparatus, and expense of lowering packet chimneys.

23. Method of lowering chimneys to pass the Bridge, and liability of steam boat explosion.

24. Danger of lowering chimneys.

25. Artificial means, such as fan-blowers, steam-blowers, steam jet, cannot be substituted for natural draft by high chimneys.

26. Accidents and detention of packets at the Wheeling Bridge.

REGIMEN OF THE OHIO RIVER.

Professor John Locke, Cincinnati. (441.)*

The Ohio, unlike the Hudson and Delaware, has no permanent depth of water, dependent upon the back water of the ocean. It is dependent alone, for water, upon that which may be supplied to its channel by tributaries from the great valley which it drains. Its depth varies by droughts or rains, from a foot or more on the shallowest places near Cincinnati, to about 64 feet in floods at Cincinnati. It follows that at some seasons of the year, the river is scarcely navigable by the smallest boats. And all boats must be laid up a part of the season; greater or less in duration in proportion to the draft of those boats. The velocity of the current of the river, at flood, is in some degree uniform from Pittsburgh to Louisville. But as the water becomes lower, the velocity of the current becomes locally divided into rapids, occasioned by bars of sand and gravel, and in some cases by small boulders, and in a few places by ledges of rocks in place; while the intermediate portions are deeper and sluggish. These rapids present channels often narrow and tortuous, not unfrequently changing their places and course.—*Walworth's Rep.*

Col. Stephen H. Long, Louisville. (552.)

The river, in its progress downward from Pittsburgh, gradually increases in width, being only about 305 yards wide at sundry points above Steuben-

* References are to the pages of Walworth's Report. In a few instances, the Original Record of 1849 is referred to.

ville, and spreading to three or four times that width as we descend towards Louisville, where its width is about three-fourths of a mile. Hence, a rise of 15 to 20 feet above Wheeling, unaided by simultaneous freshets from the Muskingum, Kanawha, and other tributaries below, expands and becomes reduced till it dwindles to the depth of only 3 or 4 feet, on reaching Louisville.

Hence, steamers of deep draft and heavy burden, bound from any point on the upper part of the Ohio, to the mouth of the latter, in order to be sure of a sufficient depth of water to carry them over the falls, should commence their voyage when the river is at its highest stage, or nearly so—from 30 to 40 feet above low water mark: otherwise, their progress may be injuriously arrested at the falls, for want of a sufficient depth of water to cross that obstruction.—*Walworth's Rep.*

"The average height of the greatest floods in the Ohio, which have occurred annually during the 12 years mentioned in the preceding table, at the city of Wheeling, has been 33 feet; and the water at that place has been 33 feet, or over, twelve days during that period. During the same time, there have been fourteen floods in the Ohio of 30 feet, or over, at Wheeling. And the water in the eastern branch of the river, at the place where the Bridge is erected, has been from 30 to 35 feet above the level of zero upon the Wheeling water gauge, for twenty-five days in all, in the course of the twelve years, in addition to the five days, in the extraordinary floods of 1840 and 1847, when the water was over 35 feet.

Floods of from 30 to 35 feet may be considered as matters of ordinary occurrence at Wheeling.—*Commissioner's Report*, 50.

WHAT BOATS ARE BEST ADAPTED FOR OHIO NAVIGATION.

Professor Locke. (442.)

The conditions of the river require of the boats that they not only draw only little water, but that they should have sufficient concentration of power to stem the rapids, and occasionally to deepen the channel a little, by ploughing through sand as well as water. In floods, the river is generally rapid; and the difficulties of navigation are then increased by abundance of drift timber, often of the largest size, requiring to be avoided by prompt motions of the boat. All these circumstances call for concentration of the powers of the boat. The rapids and bars require the vessels to be built with flat bottoms, and in every way to be made as compact and as light as possible. The boilers must be of comparatively small cylinders of iron; and the grates, fire-surface, and engines, are also limited in size by the necessities of the case: while to gain the steam power necessary to overcome the currents at the rapids, and to travel with the speed which the public demands, the fuel must be laid thick upon the grate, and a rapid combustion

effected, in proportion to the steam required. The same necessity for the concentration of power in general, accounts for the use of high pressure steam, and of high pressure engines. The turbidness of the water, causing sediment and incrustations of the boilers, is also a reason given by practical men, for using high pressure instead of low pressure engines.

The high pressure engine, so far as I have observed, is exclusively used in the navigation of the Ohio for the above reasons; and probably on account of its compactness and simplicity, thus diminishing both bulk and weight. It diminishes the weight by dispensing with the condensing apparatus; and it diminishes the bulk by diminishing the diameter of the steam cylinder.

Edwin F. Johnston, Civil Engineer. (442.)

The conditions important to that navigation, are lightness of draft of the boats and a sufficient power in the engine to propel boats at the required speed. To this end, it is essential that the engines, with their appurtenances, should have the least possible weight. This is attained by dispensing with the condensing apparatus, and giving the cylindrical form to the boilers, so as to use with greater safety steam of a high pressure in boilers of a small size and weight. The necessarily small size of the boilers, and great power required, demands the combustion of a greater amount of fuel, relatively, in a given time, for a given size of furnace, and a suitable arrangement of the chimney, and other parts connected therewith.

The system of steam boat navigation on the Ohio is the result, evidently, of circumstances which are peculiar to that river; and it is well adapted to the exigencies of the case, which requires great power in the engines, combined with a very light draft of water by the boats. I am not aware that any important improvement can be made in the general plan adopted for propelling those vessels.

Thomas J. Haldeman, Steam Boat Master. (385.)

The Ohio is liable to sudden fluctuations of high and low water, as the river rises and falls very suddenly. The navigation is more difficult at a low stage of water, on account of the rapidity of the current, and its shallowness on many of the bars. Under these circumstances, a long boat has greatly the advantage over a short one; as a short boat squats, or sinks down, when running over shoal water, and is more liable to take a sheer on the pilot. A long boat is less affected in shoal water, on account of her length, and having more buoyancy; consequently, they can be built with lighter draft. Another advantage is, that a long boat is faster, and can overcome the resistance of the current more easily than a short boat. The reason why a short boat squats, or sinks down in shoal water, is owing to

the buckets bailing out the water under her bottom, and causing her to sink; but the wheels of a long boat do not produce the same effect, owing to the length of the boat, and its having more buoyancy. Another advantage which a long boat has in low water, is, that she can carry so many more passengers, and so much more freight on the same depth of water. Owing to these circumstances, the long boats have proved to be the most profitable. The same boats on the Ohio have to contend with both high water and low water; and it is a consideration to have them built to accomplish this. That object is attained by the Pittsburgh packets, and by the packets from Cincinnati to Louisville, of which the Ben Franklin is one.

Burton Hazen, Boat Builder, Cincinnati. (427.)

They have to encounter high and low water, strong currents, and shoals. It requires them to be built light and strong; and that they should be constructed with power sufficient to propel them through the strong currents that they may meet with.

The boats should be built with a good length of floor, or breadth of the bottom of the boat; and the floor should be continued full fore and aft, to keep the boat on the surface of the water as much as possible. And they should be built with an easy water line; that is, sharp, to overcome the strong currents. They should likewise be built long, for the purpose of keeping them up and diminishing the draft of water. These advantages are attained in the present models of our boats.

John Shouse, Pilot. (649.)

Boats of the size and class of the Hibernia No. 2, are better adapted to that navigation, than the shorter and narrower boats that can pass through the canal.

The larger boats are best adapted for that purpose, as long as there is water sufficient for them to run. Some of the boats that pass through the canal draw less water than the Pittsburgh and Cincinnati packets, but generally they draw about the same.

Large boats are better adapted to that trade, because they have more capacity for carrying freight; and can take way-freight on board, and stow it away afterwards while under weigh. On the small boats, it would be necessary to delay the boat at the place of landing, and stow the freight away, to enable us to get it all on board, for want of room. The larger boats are also more under the control of the engines on shoals, &c. where we cannot get the rudder to control them, than the small boats are.

Robert Hamilton, Wharf Master at Wheeling. (33.)

Question. What is the largest class of packets embraced in your register?

Answer. The Pacific is of the largest class that has passed the bridge. She is called a New Orleans and St. Louis boat.

Question. What is the next largest class of boats that pass the bridge?

Answer. I think the Pittsburgh and Cincinnati packets.

Question. What is the third class?

Answer. The Pittsburgh and St. Louis packets.

Question. What is the fourth class?

Answer. A class less than the third class, sometimes engage in the Pittsburgh and St. Louis trade, and sometimes in other trades, and are a class larger than what are called the low water boats. The fifth class of boats are called low water boats. Of this class are the boats running from Zanesville to Pittsburgh, the Pittsburgh and Sun Fish boats, and Pittsburgh and Wheeling boats, and one Packet running between Steubenville and Wheeling daily.

BUILDING OF STEAM BOATS, SHIPS, SEA-GOING STEAMERS, AND VESSELS OF WAR, ON THE OHIO.

Col. Long. (552, 557.)

The abundant resources of the Ohio and its tributaries above Wheeling, and the facilities afforded there for ship building, of all sorts and sizes, are entitled to notice in this connection. In order to render these advantages duly available, vessels as well as steamers of the largest classes, with full freights on board, ought to have the opportunity and privilege of starting on the summit of the highest flood that may be presented, and of proceeding on their voyage without interruption from bridges or other artificial impediments.

The Mississippi and its tributaries, especially those running from the east, flow through immense forests of timber, well adapted to ship building of all kinds; while copious supplies of iron, and other materials adapted to the same purpose, may be derived from the hills adjacent to the streams.

At innumerable points on the principal rivers, from their navigable sources downward to their debouchures, frigates, war steamers and other craft required for the protection of our coasts and harbors, also steamers and other vessels required for foreign as well as domestic commerce, may be built, furnished, freighted and conveyed downward; especially in seasons of very high water, on their way to their destined ports, whether at home or abroad.

Hamilton Smith. (622.)

Have you given any attention to the facilities, on the Ohio and other western rivers, for ship building; if yea, state what those facilities are, and your opinion as to the probable increase of that business on these rivers?

"I have given attention to that subject. The facilities are that the cheapest, and most accessible, and the most abundant ship timber, of which we have any knowledge, is found on those waters; and that the cheapest subsistence, the cheapest hemp for cordage, the cheapest and best iron and copper for fastenings, are also found there. There is also, at the appropriate and most convenient seasons of the year, abundant water in those rivers to float ships to the sea, fully laden."

"Of the whole number of steam boats built the last three years in the United States, *two-thirds* were built on the western waters; and, of this number, one-sixth were built in Ohio, and one-seventh in Cincinnati. The largest number of steam boats built at any one place were built in Pittsburgh. In 1836, there were 143 steam boats, carrying 24,000 tons, navigating the western waters. In the last five years there has been built 1000 steam boats. Of these, 700 were built on the western rivers. The life of a steam boat does not average more than five years, but there are a large number which have been repaired, and are much older than five years. It is safe to say, then, that there are more than 800 steam boats now running on the western waters; and, averaging their tonnage at 200 tons each, carrying *one hundred and sixty thousand tons of freight.*"—*Evansville Memorial. Walworth's Rep.* 613.

Jabez Woodward.

Answer. I am now constructing two sea-going vessels at Shousetown, on the Ohio River, 15 miles below the city of Pittsburgh; these vessels are steamers; their machinery is being constructed in the city of Pittsburgh; they are double decked vessels, and probably would register about 500 tons each.

About eighteen months ago, I built a two-masted steamboat at Pittsburgh, which was intended for the Oronoko trade, in South America. She was built stout and heavy, sufficiently so to cross the ocean safely.—*Original Record*, 238.

Question. What port on the Ohio River affords the most advantages for ship building; and specify those advantages?

Answer. My knowledge of the subject does not extend below New Albany, on the Ohio River. From New Albany up, so far as I know, I think Pittsburgh has advantages superior over any other place below it. It is situated at the junction of two rivers; the oak timber, wanted for ship building, coming down the Monongahela, is of a very superior quality; and the pine timber wanted can be obtained from the Allegheny, this being the market for both rivers. Locust timber is abundant and cheap at Pittsburgh and its vicinity; it is a timber that is used very extensively in ship building. Labor is cheaper here than at any other point below on the river. I

have inquired at Cincinnati, Louisville and New Albany; have not inquired at other places. Machinery is produced a little cheaper here in consequence of the low price of fuel; and the price of labor is a little lower. Copper is cheaper here; it is smelted at this place, and at no place below this on the Ohio that I am aware of. In copper fastened vessels a good deal of copper is used; and vessels are built here sometimes with copper fastenings. The last two vessels I have built have copper fastenings. In building steam vessels it is necessary that they be built in the vicinity of large foundries and machine shops—and they can be built on this river only at those places that have them: such as those at this place and Cincinnati and Louisville.

Question. Are these advantages of building mast ships at Pittsburgh in any way counteracted by the bridge at Wheeling, so that they cannot pass with their masts shipped?

Answer. Yes, I think they are.

Question. What effect, in your opinion, has the Wheeling bridge upon the establishment of ship yards at Pittsburgh?

[Objected to, and objection overruled.]

Answer. I think it would have a very injurious effect, because the character of this river is very peculiar. The river may rise here very suddenly, and the vessel may have started here on that rise, and if her masts are in she may proceed to sea in that high water; but if she has to stop for a day or a week, to ship her masts, below the bridge, the water may fall in the meantime, and the vessel be detained so that she would not be able to get down until the next flood. That was the case with the vessel I have now at New Albany. I consider the damage to me, in that vessel, from 5 to $10,000. I would not establish a ship yard at any place with such an obstruction, and engage permanently in the business of ship building.—*Walworth's Rep.* 50, 51.

Charles Thoms.

I am a naval architect, and have been engaged in that business at New York fifteen years, and am now engaged at Shousetown, 13 miles below Pittsburgh, in superintending the construction of two steam propellers for the Oronoko Navigation Company; each are to be 440 tons Government measure, 167 feet long, 24½ feet wide, carrying three masts; the longest mast to be 98½ feet high above the surface of the water, one 88 feet high, and one 79 feet high.

What is the usual height of masts of sea-going vessels?

The height varies; small class vessels, of 200 tons, require a mast of 100 feet—large ships, 150 feet high. The mast of a vessel like the Allegheny, constructed at Pittsburgh a few years ago, would be about 139 or 140 ft. high.

What are the advantages of constructing such vessels at Pittsburgh and other points on the western waters?

They can be constructed at Pittsburgh 20 per cent. cheaper than on the sea-board; this is the estimated difference in constructing the boats which I am now superintending.—*Original Rec.* 240.

Joseph Tomlinson.

Have you been engaged in the construction of ships or other sea-going vessels? If yea, say first what description of vessels; where, when, and for whom, they were constructed; second, by what means were such vessels to be propelled, and were they to be rigged.

Answer. I have, of iron vessels; three of them were vessels of war, and a fourth one was afterwards converted to the same use. Three of them were built for the Government of the United States, and one for an individual. They were built within the last seven years, here, at the city of Pittsburgh; one of the Government vessels was put together on Lake Erie, the other three were launched here; they were to be propelled by steam; they were all masted and rigged vessels; one was not masted here, she was masted at the Memphis navy yard.

Interrogatory 2d. What facilities, with respect to skill and materials for the business of constructing such vessels, exist at or near Pittsburgh, Pennsylvania, and what materials are chiefly required for that purpose?

Answer. With regard to skill, I think them equal to those at any point in the United States; with regard to materials, I think them superior to any; the machinery for preparing the metal is superior to that at any other point known to me; iron is the material mainly used, and it is of this that I speak; the timber was gotten here for the masts of the Government steam ship Allegheny—they were prepared here in my yard, and put up at Memphis, Tennessee; timber for masts, and ropes for rigging them, could be gotten here.

Interrogatory 3d. What stage of water in the river is required for such vessels to clear from the place of their construction to the sea-board; and what space is required for the free navigation of the river by such vessels with masts, and full rigged?

Answer. As the Allegheny went out, I should have considered it unsafe for her to have gone on less than 16 feet; she went out unfinished; completely fitted, she would have required 20 feet; her breadth of beam was something near 33 feet; from the surface of the water to the top of her masts the height would be about 90 feet, I think; I am not positive as to the exact height; I did not furnish them.

Interrogatory 4th. What effect would a bridge at Wheeling, 93 feet above low water mark, have on the navigation of the river by such vessels as those of which you have been speaking?

Answer. The Allegheny, as she went out, could go under the bridge on a 20 foot stage of water; had she been masted she could not have gone under the bridge at all; one of the other vessels, the revenue cutter Walker, I think, could not have gone under the bridge; she was rigged here, fitted out entirely.—*Original Record*, 244.

Burton Hazen. (428.)

The steamer Ann Chase was built for the Government, at Cincinnati, in 1847, for a transport ship; she was 120 feet keel, 30 feet beam, and 9 feet depth of hold. She had but one mast, which was, I think, 60 feet high from the top of the kelson. The steamer Fanny was built in 1847, at Cincinnati, for John D. Deshon, for a coasting vessel. She was chartered by the Government during the Mexican war. She was, I think, 110 feet on deck, and 95 feet length of keel; 28 feet breadth of beam, and 10 feet depth of hold. Her carpenter's tonnage was 175 tons. Her main mast, I think, was 72 feet from the top of the kelson. She came up to Cincinnati in 1848, with her masts down, and was repaired; a new boiler was put in, and other improvements made. The brig M. P. Cassilly was built at Cincinnati, in 1847 and 1849, for a coasting vessel. She was built for Capt. Wright and others. She was 75 feet long on deck, 24 feet breadth of beam, and 9½ feet hold; and measured 144 tons, carpenter's measure. Her main mast was about 80 feet high from the kelson, which was about 2½ feet below the surface of the water when light.

John Leatherberry. (430, 432.)

State the name and dimensions of the ship built by you, and how she was to be propelled.

Answer. Her name was the Minnesota. She was 160 feet long on deck, 33½ feet breadth of beam, and 22 feet depth of hold; and measured 800 tons, custom house measurement. She had three masts; the main mast was 140 feet long, and the other two masts were some 8 or 10 feet shorter. She was built for the New York and Liverpool trade. She was owned in New Orleans and Mobile. She went over the Falls, with her masts unshipped. We intended to ship her masts here, but the water rose and we took her down without shipping them. She was to be propelled by sails alone.

Question 3. How many sea-going vessels have been built at Cincinnati, since you have been in business here; and of what classes?

Answer. I believe five; 1 ship, 2 schooners and 2 brigs. I can afford to build 20 per cent. below the New York prices, at Cincinnati.

COMMERCE OF THE OHIO RIVER.

Charles Cist. (437.)

Have you made any investigations in regard to the commerce on the Ohio River, and especially at the port of Cincinnati; if yea, state the general result?

Answer. I have made such investigations from actual knowledge, at the port of Cincinnati; particularly in 1848. I have made enquiries as to the commerce on other parts of the river, but have no personal knowledge as to it. The result of such investigation has been, that there was an import of nearly $50,000,000, in that year, into the port of Cincinnati, by the river, canals, and rail road; besides some by land, which I could not ascertain. The exports were nearly $56,000,000; for the same year; including exports by canals and rail roads. Of the imports and exports, I should judge that at least three-fourths goes by way of the Ohio River; but I have kept no account by which I can ascertain the proportions accurately.

John Holmes.

State, as nearly as you can, what you estimate the average annual value of goods, merchandise, manufactures, and freight in all of its varieties, shipped at the port of Pittsburgh, and destined to points west of Wheeling; and also the amount received at Pittsburgh, coming from points west of Wheeling?

I made an estimate during the summer for the year 1848, and came to the conclusion that I should be under the mark at $40,000,000. This estimate was of course a very rough one, but from all the information that I could gather, I feel confident that my estimate was not too high.—*Orig. Rec.* 279.

Not less than *twenty thousand miles* of river coast is accessible by steam boat navigation.—*Evansville Memorial*, 614.

Hamilton Smith. (621.)

I think the estimate is from 8,000 to 15,000 miles too small, estimating both sides of the rivers as coast. The best estimates that we have, thus far, of the length of the navigable waters of the Mississippi and its tributaries, vary from 12,000 to 17,000 or 18,000 miles.

COMMERCE OF THE PITTSBURGH AND CINCINNATI PACKETS.

Samuel Hibbard. (432.)

I have been agent for a portion of the Pittsburgh and Cincinnati packets for several years.

What proportions of the steamboat passengers and freight, passing between Pittsburgh and Cincinnati, are carried by the Pittsburgh and Cincinnati line of packets?

I suppose about three-quarters of the passengers, during the time that those boats run, go on them; and I suppose they carry about half of the freight during the same time.

Robert Getty. (436.)

I have been engaged in the navigation of the Ohio about eighteen or twenty years—a part of the time as clerk on a steam boat, and a part of the time as captain. I am now engaged as a steamboat agent, and in the commission business. I was captain of a boat about ten years.

Are you acquainted with the packets known as the Pittsburgh and Cincinnati line of packets? If yea, state what proportion of the passengers and freight, passing between Pittsburgh and Cincinnati, those packets carry.

Answer. I am acquainted with those packets: they are seven in number—one for each day in the week. I should suppose they carry half the freight, and at least three-fourths of the passengers, during the time they are running.

David Holmes. (656.)

One or more new boats have been brought into the line each year, for the last eight years. In 1845 and 1850, two new boats were brought in each year. As new boats are brought in, they have been gradually increased in size ever since I was acquainted with the line; and the old boats have been broken up or sold out, as they were not wanted.

Edwin Wells.

Seven packets form a daily line. They average annually thirty trips each from Pittsburgh to Cincinnati, and the same number from Cincinnati to Pittsburgh, making in all for the seven packets, four hundred and twenty trips per year. They carry 84,000 passengers, and 42,000 tons of freight annually.—*Original Rec.* 202, 204.

DESCRIPTION OF THE WHEELING BRIDGE.

The length of the bridge is 980 feet between the faces of the two abutments; and 1010 feet between the centres of the two towers, at each end, which support the cables upon which the flooring of the bridge is suspended.

At the highest part of the bridge, for the distance of about 56 feet in width, there is a clear headway, for the passage of steam boats with their chimneys standing, of 92 feet above zero of the Wheeling water gauge; or

91 feet above extreme low water. This headway commences about 174 feet from the top of the face of the eastern abutment, and terminates 750 feet from the same point in the western abutment. *But this space of* 56 *feet in width is not over any part of the river at extreme low water.*

The bank of the river under the eastern extremity of the 56 feet space, is 10.21 feet higher than the level of zero of the wheel-gauge; and under the western extremity, the height of the bank above zero of the gauge is 3.81 feet. And it is only 22 inches below zero of the gauge at a point 100 feet further west. The water upon the Wheeling bar must therefore be about 4 feet deep, to bring the easterly edge of the stream to a point under the western extremity of the 56 feet. And it must be more than 15 feet deep upon the bar to enable a steamboat drawing 5 feet to avail itself of the 91 feet of clear headway above low water mark, for the whole width of 66 feet.

It follows from this statement of the facts, that a steamboat drawing five feet, and whose chimneys are 79½ *feet high, or over, can never pass under the* APEX *of the bridge, at any stage of the water, without lowering her chimneys. And boats drawing* 4 *feet and having chimneys as high as* 86 *feet can never pass under any part of the bridge, without lowering, even in stages of water between* 4 *and* 12 *feet high on the Wheeling bar.—Commissioner's Report*, 27—28.

I do not wish it to be considered as holding out any promise that the Wheeling bridge, as it is intended to be constructed, can be safely used for the passage of locomotive engines.

The work is designed expressly for common travel and the use of heavy teams.—*Ellet's Report to the city of Wheeling*, (*p* 323 *Walworth's Rep.*)

The Wheeling bridge, intended for the heavy teams and droves which traverse the National Road, is 24 feet wide.—*Ellet's Report to the Cincinnati Bridge*, (*Walworth's Rep.* 449.)

ADAPTATION OF THE BRIDGE TO RAIL ROAD PURPOSES.

William J. M'Alpine, Commissioner's Engineer. (673.)

In compliance with the instructions, to inquire as to the adaptation of the bridge, as now constructed, to rail road purposes, for the passage of loaded trains of rail road cars, drawn either by locomotives or by horses, I have to reply, that I am satisfied that the bridge as now constructed, is not adapted to such purposes.

THE WHEELING BRIDGE OBSTRUCTS NAVIGATION.

I have arrived at the conclusion, and do accordingly decide and report, that the Wheeling suspension bridge, referred to in the pleadings and proofs

in this case, is an obstruction of the free navigation of the Ohio, at the place where it is erected across the same, by vessels propelled by steam, which are now engaged in the commerce and navigation of that river, and by such vessels as will undoubtedly be engaged in such navigation and commerce hereafter, at that place, while such bridge is permitted to remain without very material alterations.—*Commissioner's Rep. xlv xlvi.*

Jabez Woodward. (49.)

Question. State whether the bridge at Wheeling will obstruct the passage of sail vessels with their masts in at high water?

Answer. No sail vessel could pass under the Wheeling bridge with her masts in at the highest stage of the water. I suppose the highest stage to be over 40 ft. No sailing vessel of any magnitude could pass under the Bridge with her main mast up at a stage of water 25 feet high. The masts of the schooners on the North river vary from 70 to 90 feet. Vessels such as the one I now have here on the stocks, would have their main masts about 70 feet above the water, and could pass under the bridge with 20 feet water.

Charles Batchelor. (76.)

Question. What effect has the slope of the bridge upon the navigation under it?

Answer. If the bridge was on a level with its highest point it would allow pilots more room for passing; they now generally try and pass under at the highest point of the bridge. Boats very frequently become unmanageable by the tackle breaking, or getting foul in some way; if that should occur any where near the bridge, in high water, with the boat under full head way, there would be danger of her getting too far out from the highest point of the bridge, and running foul of the bridge.

Solomon W. Roberts, Civil Engineer. (652.)

State your opinion as to the effect of the Wheeling bridge upon the navigation of the Ohio river, by vessels propelled by steam or sails?

I consider it an obstruction to large vessels, whenever there is a considerable depth of water in the channel.

Edwin F. Johnston, Civil Engineer. (267.)

I consider the present Wheeling bridge an obstruction, to a certain degree, to the passage of steamboats and other vessels on the Ohio river. And this obstruction will increase, should the future wants of the public demand the use of vessels of larger dimensions than those now running upon that river. If many other similar obstructions are erected, along the Ohio river, its navigation will, I think, be seriously and injuriously affected.

Col. S. H. Long, Supt. Western river improvements. (559.)

With respect to the effects of the Wheeling bridge upon the navigation or commerce of the Ohio, they are in my opinion decidedly injurious.

Sea vessels and steamers of the largest class on the western waters would not attempt to navigate the Ohio at any stage less than ten feet above extreme low water. The height of the main masts and chimneys of such vessels and steamers, would not probably be less than 90 to 100 feet above the water. Of course all such craft would be effectually barred from passing the bridge with their masts and chimneys standing.

My views, in relation to the passage of the Pittsburgh packets, and other craft, under the bridge, have been presented in a former answer; all conspiring to corroborate in my mind the opinion that the Wheeling bridge is to be regarded as a serious obstruction to the navigation of the Ohio.—*Col. Long.*

DEFENDANTS KNEW THEIR BRIDGE WOULD OBSTRUCT NAVIGATION.

Israel Dickinson, Civil Engineer.

I became connected with the work before any portion of it was done, on the 1st of August, 1849, and have continued upon it to the present time, as assistant Engineer. While in Philadelphia, previous to my coming to Wheeling, I assisted the principal Engineer in drawing the original plan, and calculating the different portions of the work, and in making estimates.

We were aware that there were some boats with chimneys so high, that they would be unable to pass under the said bridge, on the highest freshets, without having joints in their chimneys. Those few boats which would not be able to pass under said bridge in said freshets, were not provided with joints in their chimneys for lowering them.—*Original Rec.* 367, 381.

"The board of managers, after an anxious inquiry and investigation on the subject, have fixed the maximum heighth of the bridge at 90 feet above the low water level. A rise of thirty feet gives sixty feet clear over the steamboat channel, a space amply sufficient for the great majority of the craft navigating the upper Ohio, to pass without the necessity of lowering their chimneys; *a few of the large class of boats, at such a stage, will be compelled to do so.*" They therefore pray that their charter may be so amended, as to fix by law the maximum elevation, above low water level, at ninety feet.—*Memorial of the Stockholders to the Virginia Legislature, 1st January*, 1849. *Original Rec.* 56.

HOW THE BRIDGE SHOULD BE ALTERED.

Floods from 30 to 35 feet may be considered as matters of ordinary occurrence at Wheeling. Provision should therefore be made for the pas-

sage of steam boats under the bridge, with their chimneys standing, at those stages of the water, in altering the construction of the present bridge so that it will not obstruct the navigation. And as some of the boats which navigate the river from above the bridge, have chimneys about 85 feet high from the surface of the water, *the head way at the bridge should be at least* 120 *feet* above the level of zero upon the Wheeling gauge; so that boats can pass the bridge as altered, with safety, upon a thirty-three feet stage of water, with 85 feet chimneys standing, without slackening the fires or landing the boat above the bridge. To do this there should be two or three feet in the clear, above the tops of the chimneys.

In the bridge, as it should be altered, this clear level headway for the passage of steamboats, with their chimneys standing, should be over some convenient part of the channel; and not less than three hundred feet in width. So that there will be no difficulty in getting under the highest part of the bridge; and so that two boats may also pass each other with safety, at the bridge, if it should become necessary for them to pass at that place. —*Commissioner's Report, l.*

E. F. Johnston, Engineer. (227.)

I have made a rough estimate, in my mind, of the cost of raising the suspension bridge at Wheeling to a height of 130 feet above low water—a portion of the bridge of this height to be four hundred feet in extent; the remainder of the road way to incline in the same degree as the present bridge now declines. My opinion is that this change can be effected for between ninety thousand and one hundred thousand dollars. I have also made a similar estimate of the cost of a truss bridge, similarly elevated; which amounts to from $130,00 to $150,000. My data for these estimates I derive, not from any measurements made by me, or under my direction, but from such information as was furnished by the report of Mr. Ellet, in relation to the construction of this bridge, and from my own observations as to what was requisite, made on my visit to the locality.

Col. Long, (559.)

What elevation do you consider necessary for a bridge, without a draw, over the Ohio river, so as to preserve navigation for steamboats, and sail vessels; state also your reasons?

Answer. As I have before stated, I am decidedly of the opinion that the clearance between the bridge floor and the summit of the highest flood ever known in the Ohio, for example the flood of 1832, should in no case be less than 90 to 100. Accordingly the height of the bridge above extreme low water, should not be less than 134 feet at Wheeling. At Cincinnati not less than 153 feet, and at Louisville not less than 131 feet. I am moreover

of the opinion, that all bridges across the Ohio should either be raised to the heights above stated, and to corresponding heights on other parts of the river, or be accompanied by draws of the character given in a previous answer.

John A. Roebling, Civil Engineer.

I am acquainted with the locality of the Wheeling bridge, having made the surveys necessary for the planning and execution of such a structure. A bridge might have been constructed at an elevation in the centre of 25 feet more than the elevation of the one erected, or about 120 feet in the clear above low water, by simply continuing the rise of the floor at the rate of five feet in a hundred from the abutments to the centre—a distance of 500 feet. Both abutments would have to be 95 feet high from low water to the base of the towers; the latter would require a further height of about 100 feet; total, 195 feet. *There is ample distance on the island to effect a descent.* If there was any absolute necessity for a still higher elevation, more might be obtained by going further back with the approaches, and by increasing their rate of ascent. *Original Record.* (180.

Solomon W. Roberts, Esq.

I am a civil engineer, and have been so engaged for the last 22 years.

Have you examined the site of the Wheeling and Belmont bridge, about being erected across the Ohio river?

Answer. That he has, several times.

What, in your opinion, would the wire suspension bridge at Wheeling have cost had it been elevated to 120 feet above low water, more than at the elevation of the present bridge?

Answer. I can give but a general answer: my impression is, that it would have increased the cost about one fourth.—*Original Record.* (131.)

NECESSITY FOR HIGH CHIMNEYS.

"In relation to the question whether chimneys as high as those now in use upon the Pittsburgh and Cincinnati packets, and some of the larger boats on the Ohio, are necessary for obtaining the maximum of speed desirable in the navigation of the river, there is a diversity of opinion among the witnesses: especially among those who are not acquainted with the scientific principles of chimney draft in reference to the combustion of fuel for the generation of steam. But I think there is a great preponderance of the testimony in favor of the necessity of very high chimneys upon the large Ohio steamboats.

The teachings of experience show, that as boats upon the Ohio have been gradually improved in their dimensions, from time to time, and the heights

of their chimneys increased, they have been enabled to run with greater speed; to the evident advantage of commerce, and of travel upon the river. And the fact that several different projects for procuring artificial draft, as an available substitute for the draft of tall chimneys, have been tried upon the western waters and have failed and been abandoned, is very strong evidence in favor of the necessity of natural draft for the combustion of wood and bituminous coal upon the steamboats navigating the Ohio.

The deductions of science also show that the draft is increased by elongating the chimneys. And most of the scientific witnesses, who profess to be acquainted with the principles of natural philosophy which regulate or affect the draft produced by chimneys, admit that the height which will produce the maximum of draft has never yet been attained by any chimneys, either upon steamboats or elsewhere."—*Commissioner's Report* 35, 36.

STEAMBOAT FUEL ON THE OHIO RIVER.

Edwin F. Johnston. (224, 225.)

The fuel principally used on the boats on the Ohio river is bituminous coal, obtained at various places along the river. From the best knowledge I possess, they have been enabled to effect the combustion of it, with sufficient rapidity, by means of what is commonly called the natural draft.

The cost of fuel on the Ohio river is much less than on the eastern rivers. The price of bituminous coal on the Ohio, in particular, being only 4½ cents per bushel; or from 1,25 to 1,50 per ton. This is much below the cost of wood, or of mineral coals, used on the eastern waters, to produce the same effect. In consequence of the low price of fuel on the Ohio, it is not necessary to economize in its use in steamboats on that river. Hence a mode of using it may be adopted which would not be admissible under other circumstances.

NATURAL DRAFT, BY HIGH CHIMNEYS, THE BEST METHOD OF PROPELLING STEAMBOATS.

Professor Renwick. (p. 102, 108.)

Question. In general, if the following mechanical problem was to be solved, viz. To obtain on a boat a maximum power of propulsion with a minimum weight of boiler and engine, and with a limited extent of fire surface, and to use bituminous coal or wood, what would you suggest as the most economical and effective arrangment; having regard to the pressure of steam used and the mode of obtaining draft?

Answer. It would be most economic to use steam of the highest tension consistent with safety, because a given quantity of water converted into steam has a more powerful mechanical effect. The engine adapted to this

high steam would be smaller, and therefore of less weight; thus meeting the condition of small draft in the vessel. To generate this high steam, I would use long cylindrical boilers of the smallest admissible diameter; because by them a given fire surface would be obtained with boilers of less weight themselves, and containing a weight of water still less in proportion than the reduction in their own weight. *And in order to obtain a sufficient draft in the long narrow flues adapted to such boilers, I would use a chimney as high as could be properly stayed upon the vessel.*

Question. Would or would not, in your opinion, the deductions of science warrant any such expression as the following, "the height of a chimney for a boat need never exceed 60 or 70 feet, or any such fixed number, for all practical purposes." Must or must not all such height be conditioned to the particular exigencies of combustion in each case?

Answer. I should not consider that any number could be fixed, either scientifically or practically, to meet every case; being under the impression that chimneys rarely or never reach the height most advantageous for draft. I consider the proper height of the chimney of a steam boat to depend upon the dimensions of the vessel, and the means which the vessel furnishes for staying and supporting it, rather than upon any other circumstance.

The maximum amount of draft, in a chimney, is reached when the air in the chimney, that reaches its top, has the same temperature as that of the neighboring atmosphere. This is a height which is probably never reached in any chimney. The general rule is, the higher the chimney the better the draft.

Professor Byrne. (117.)

The boiler and machinery should be very light. The pressure of steam must be very high. *And I would depend on the due length of chimney for draft, instead of blowers; because the additional pipe, for the chimney, is lighter than the machinery composing the blowers. There would be more economy, also, in a long chimney;* because draft would act with greater steadiness and uniformity. Besides you lose no steam power by lengthening the chimney; when you would by using the blower.

Question. Would or would not the deductions of science, in your opinion, warrant such expressions as the following: "The height of the chimney of a boat, from the grate surface, never need exceed 60 feet, or any fixed number, for all useful practical purposes?"

Answer. I think such an expression could not properly be made use of.

Question. Must or must not every such height, for maximum draft, be varied according to the conditions of combustion in the particular case?

Answer. It must.

Joseph Curtis, Steam Engine Inspector. (143.)

Please state your views as regards natural draft; and the mode of obtaining the best draft for steamboats?

If the chimney is of the appropriate size, in proportion to the flues, as heretofore stated by me, and I find I have not sufficient steam, I would add to the length of the chimney until the heat leaving the chimney would be but a few degrees in temperature above that of the surrounding atmosphere.

Edwin F. Johnston. (224, 226.)

Please state to what extent, in your opinion, the height of chimney influences the amount of draft; and whether you can refer to any authors on the subject, or any calculations of your own, to show the extent of this influence?

I am not able to state, from any information I possess, at what height the drawing effect of a chimney ceases. It is, however, beyond that attained by any of the chimneys which I measured on the Ohio. The conclusions which I draw from my investigations of this subject, are that the draft does not cease to be augmented under a height of chimney of 100 feet, with a suitable diameter. I am of the opinion that the height of the chimneys upon the boats measured by me can not be advantageously lessened. I do not know of any so good mode for producing draft for combustion, on board the boats I examined on the Ohio, as by chimneys of suitable lengths and diameter.

Professor Locke. (444.)

What is the most economical and effectual means for steam boats on the Ohio river using wood and bituminous coal, to attain a maximum power of propulsion with a minimum weight of boiler and engine, and with a limited extent of grate and fire surfaces; having regard to the pressure of steam and the mode of attaining draft?

By increasing the natural draft by chimneys as high as circumstances would permit.

What rule, or natural law, regulates the maximum height, proper for steam boat chimneys?

I do not know that there is any absolute rule on that point. The height of a chimney, of suitable diameter, would continue to increase the draft until it would reach the point at which the contents of the chimney became condensed, by cooling, to such extent that their specific gravity would be equal to the specific gravity of the air outside of the chimney. As the products of combustion, in the chimney, are naturally heavier than common air of the same bulk, this condition of equilibrium, would take place rather before the gasses in the chimney were cooled down to the temperature of the surrounding atmosphere. The tallest chimneys of our boats are far

short of the height due to this maximum draft; and are probably not supplied with the greatest draft desirable. It follows then that circumstances of mechanical convenience must regulate the maximum height of steam boat chimneys.

Col. Long. (553.)

The more elevated the chimney and the higher the temperature of the rarefied column within it, the more rapid will be the ascent of the column, and the more powerful will be the natural draft.

Professor Bartlett. (156.)

If you increase the height of the chimney you will increase the draft: this certainly will be the case in a stationary engine. What would be the effect in the case of a chimney moving rapidly through the atmosphere, and subjecting a greater surface to its cooling influence, (for the draft depends upon the internal temperature of the air,) I cannot say: but I am inclined to believe that there would always be an increase of draft, as long as the mean temperature of the internal air was below 300 degrees centigrade, or 572 of Fahrenheit, the external air being at 32 Fahrenheit. And even when the temperature of the internal air somewhat exceeds 572 Farenheit, the external air being still at 32, if that increase of temperature is caused by an increase of height of the chimney, it will still increase the draft to a certain extent.

THE DRAFT OF A CHIMNEY DEPENDS NOT UPON ITS DIAMETER OR CUBIC CAPACITY.

Professor Renwick. (99, 111.)

Question. Does increasing the diameter of a chimney increase the force by which the air is driven or drawn through the chimney; and does the increase in the diameter act beneficially in any other way than by diminishing the friction of the air in its passage through the chimney?

Answer. Supposing that the area of the chimney is sufficient for the passage of all the air necessary for the combustion of a proper quantity of fuel, with the velocity due to the height of the chimney, any further increase of diameter will have no effect upon the force of draft except by a diminution of the friction. And such further increase of diameter would be positively injurious to the draft of the chimney, unless the area of the chimney at the top were again contracted to a space just sufficient to permit the passage of the air, at the temperature to which it is there reduced, with the velocity as before, to the height of the chimney.

Question. Does or does not the force of draft depend upon the cubic capacity of the chimney?

Answer. The mere force of the draft, measured, or indicated, by the velocity of the ascending current of air, has no relation whatever to the cubic capacity of the chimney. To say that an equal draft may be obtained by diminishing the height of the chimney and increasing its area, so as to retain the same capacity, involves or includes the absurdity that the fire under the boiler would burn better without any chimney at all.

Professor Byrne. (115.)

Question. Does or does not increasing the diameter of a chimney increase the force by which the air is driven or drawn through the chimney; and does or does not this increase in the diameter act beneficially, in any other way than by diminishing the friction of the air in its passage through the chimney?

Answer. The diameter is never increased for the purpose of increasing the draft; but for the purpose of decreasing the friction.

Professor Bartlett. (173.)

Question. Does it appear from your calculations, and from the dimensions of any of the western boats which have been supposed by the respondent's counsel, in their questions, that the chimneys alone could be increased in diameter, with any advantage except that due to the diminution of friction.

Answer. It does not appear from any calculations I have made that they could; retaining their other dimensions unchanged.

HIGH CHIMNEYS REQUIRED BY THE LIMITED SPACE ON STEAMBOATS FOR BOILERS AND FIRE SURFACE.

John Howell, Engine Builder. (177.)

Fuel can not be consumed as economically on steamboats as in land engines. Because we have larger boilers and more grate surface upon land engines than upon steamboats. We do not require so strong a draft on the land engines, because we have larger boilers and more grate surface. We can not get the same extent of boiler and grate surface on steamboats, for want of room, and because it increases the weight too much—two things we have to contend against in building boilers for boats. With the larger fire surface which we can obtain in the construction of land engines, we are enabled to communicate more heat to the water in the boilers, from the consumption of the same fuel, than we can do upon steamboats, where we are obliged to contract the fire surface and to obtain a greater amount of draft.

Professor Bartlett. (173.)

Question. Are you not of opinion, from your solution in answer to the 14th direct interrogatory, that supposing the boat therein alluded to,

burned or desired to burn 32 bushels per hour, on her grate surface as there given, her present chimneys are as short as they ought to be for that purpose; supposing them to be 55 feet high above the boilers?

Answer. I am of such opinion.

PRACTICAL ADVANTAGES OF HIGH CHIMNEYS.

Capt. Heslep. (45.)

Question. What, according to your experience, is the best method of procuring draft to the furnaces of steamboats; and your opinion of the benefit and use of large and high chimneys on boats such as the Telegraph, or boats of her size?

Answer. I can not say, except from a little experience on Telegraph No. 1. The first spring she ran, she made steam very badly; we could not get any thing like the steam she could work; in the fall, when I took charge of her, I suggested the idea of lengthening her chimneys, which was agreed to; and we lengthened them 8 feet; I think she ran about half a mile an hour, up stream, faster than before; that is, she made steam much better.

Captain Devol. (55, 56.)

They lessen the complication of machinery; it lessens the care and responsibility of the engineer; and it lessens expense in running the boat, and lessens the cost of apparatus for increasing the draft.

Question. What effect did the shortening of the chimneys have upon the draft of the furnace, and speed of the Clipper.

Answer. I think it made difference of from two to three hours in our passage up from Cincinnati to Pittsburgh. We could not consume as much fuel, and consequently could not make as much steam; the draft being lessened.

Samuel Young, Engineer. (71.)

Question. Were the chimneys of the Clipper shortened, at any time, to pass the Wheeling bridge?

Answer. Yes; they were shortened four feet while I was on her.

Question. Did the shortening of the chimneys produce any effect on the boat, in her speed or capacity to produce steam?

Answer. Yes; she did not make as much steam.

Charles Batchelor, Pilot. (77.)

Question. Has the height of the chimneys any effect upon the piloting of a steamboat; and what effect?

Answer. It has considerable effect in case of a stern wind; the wind generally, in low chimneys, confines the smoke around the pilot house, and renders it difficult for the pilot to see to steer the boat; higher chimneys would carry smoke off better, and give a better chance for him to see under the smoke.

George Rowley, Pilot. (78.)

Question. Does the height of chimneys in any way affect the piloting of boats; if yea, state in what particular?

Answer. The higher the chimneys the better chance there is for blowing off the smoke; a low chimney lets the smoke farther down, and is apt to blind the pilot very much in a dark night.

Reuben Miller. (86.)

Question. Is the increased height of the chimneys any additional security to the boat against fire?

Answer. I consider a high chimney much safer than a lower one. It carries the sparks clear from the deck before settling. It was very common for boats in early times to have screens to catch the sparks; but since the use of high chimneys, screens have been abandoned.

Question. Have you noticed whether there is any difference in the quantity of combustible matter on the decks of boats having high chimneys?

Answer. I have seen over a bushel of sparks or dead embers gathered up at one time from the hurricane deck on boats having low chimneys.

Question. What boats have you seen take fire from sparks?

Answer. I have seen a boat twice on fire during the same voyage—the Le Grange, a Wheeling boat; and have seen others on fire.

Captain Grace. (42.)

We have been running with our chimneys (the Brilliant) as they were after they were cut off; it costs us as much as $10 extra each trip, because we have to use more wood with our coal; the fire has to be shaken more to increase the blaze, and the constant shaking of the fire causes a good deal of coal to be lost by dropping through the grate bars. It also increases the labor of the firemen.

Daniel Carpenter. (131.)

As it regards how high a chimney might be, I do not know; for I have always increased draft by raising the chimneys. I have never put any chimneys on steam boats, but have put them on stationary engines; though the same natural laws govern draft in all chimneys.

I have increased the height of chimneys—probably about 20, it may be a few more or less—and it has always increased the draft.

Theodosius F. Secor. (187.)

The object of a high chimney is to get draft. If you want to get rapid combustion, you must get a long chimney to do it in: or you must obtain it by artificial means. I mean by a blower. I have lengthened several chimneys, and the effect was to increase the draft.

Captain Brickell. (405, 410.)

We have always found it to be the case, that the higher we made our chimneys the more we increased the draft. We avoid the sparks, that are thrown out in great numbers when the draft is procured by blowers.

The utility of high chimneys consists in the carrying off the sparks free from the boat; in increasiug the length of boilers, having less of them in number; by increasing the draft of the chimney, and getting more room on the boat. The side room is more valuable than the fore and aft room on the boats. The tall chimneys carrying the sparks from the boat, renders it less liable to take fire when they use wood. I have been never in the habit of using coal as a fuel entirely on any boat I have been on. There is economy in using high chimneys; because we get more steam out of less wood by increasing the draft of the chimneys.

Ferguson Clements. (433.)

Question. Have you ever lengthened steam boat chimneys in order to improve their draft; and what was the effect?

Answer. I have lengthened them, when it was said by those that desired them lengthened that it was to improve the draft.

Edward Shields. (419.)

The utility of having high chimneys is to get an increased draft. We have found there is an increase of draft gotten by having higher chimneys. The higher up the chimneys are carried the less danger there is from sparks. I have often lengthened the chimneys in order to improve their draft, and without increasing the diameter. I have never increased the diameter without lengthening them. The result of lengthening them always was to increase the draft. I never knew it to fail.

**Wm. Hoffman.* (198.)

Question. If you desired to raise the pressure of steam, which you are enabled to raise in the Belle, as she now is; what alteration would you make in her chimney.

Answer. I should put another length of 7 feet upon her chimney; and if I still wanted a stronger draft, I would increase the height of the chimney still more.

* Defendants' witnesses.

Alexander B. Latta. (223.)

What height of chimney do you think would give the best draught, 45 feet or 50 feet, above the flues; or would there be no difference?

The draft of the 50 feet chimney might be a little the best, because it would be a little higher. We generally consider that by increasing the height of chimneys, that it improves the draft.

Thomas Farrell. (509.)

We have been adding to the heights of chimneys a little, as we build new boats. About 6 feet has been added to the heights of chimneys within the last six years.

John B. Martin. (520.)

Increasing the height of a chimney to a certain extent will help the draft. If the height of a chimney was less than once and a half the length of the boiler, I think it would increase the draft to lengthen it. I can not say whether the draft would be increased by lengthening the chimneys beyond that.

Wm. Miller. (582.)

Question 2. Why did you lengthen the chimneys of the Telegraph No. 1?

Answer. I thought it would increase her draft; which was not sufficient before.

John Shallcross. (623.)

Question. Has not the size of chimneys increased very much within the last few years?

Answer. Chimneys have increased, both in diameter and height, within the last few years.

Question. What advantages have been derived from the increased height and diameter of chimneys?

Answer. An increased draft.

PROGRESSIVE INCREASE IN SIZE OF WESTERN BOATS AND THEIR CHIMNEYS.

Samuel Young, Steamboat Engineer. (70.)

Question. What changes have been made in the construction of steam boats and their boilers, within the last few years, between Pittsburgh and Cincinnati?

Answer. The boilers and chimneys have both been made longer in boats concerned in the packet trade between Pittsburgh and the falls of the Ohio;

and there is a less number of boilers in proportion to the size of the boats. The boats are increased in size.

Question. What has been the effect of such changes upon the speed and power of the boats?

Answer. To give more speed and power with less fuel.

Reuben Miller, Engine Builder. (80.)

What changes have been made in the construction of boats and their chimneys since you have been engaged in them?

They have been increased in size very much; and the chimneys have been increased in their height and diameter, in proportion to the size of the boats.

The boilers, in many instances, have been reduced in number in boats of the same class, and the same speed obtained by improved application of the power; that is, by the enlargement of the opening of the valves of the cylinders, the improvement and enlargement of the fire-beds and chimneys, and the increased height of the chimneys, for the purpose of increasing the draft and the steam.

Capt. Thomas J. Haldeman. (380.)

The boats are now built much longer and wider than formerly, and deeper in the hold; and the heights of their chimneys have been much increased. In 1820 the longest boats on the Ohio and Mississippi river were about 90 feet in length; and now some of the boats are 305 feet long. And the chimneys have been increased in height and in diameter in the same proportion, or very nearly so.

The commerce of the country has increased so rapidly that it requires larger boats to do the business, and these larger boats have proved more productive to the owners. The prices of freight and of passage have both been very much diminished; and the speed of travel has been increased. In 1820 the cabin passage from New Orleans to Cincinnati was from 100 to $125, and now it is from 15 to $20. There is about the same relative difference in the prices of the downward passage, and about the same relative difference in the prices of freight both up and down. In 1820 it took from 25 to 30 days to make a trip from New Orleans to Louisville; and now the average trips, with the fast boats, is from 5 to 6 days. The fast boats are of the larger class of boats. There has been about the same difference in the rate of speed between Louisville and Cincinnati. The reason why the larger boats have proved more profitable, is that their capacity has been so much increased, for passengers and freight, without much additional expense in running the boats. The reason is that the same power that drives a boat 182 feet long, will drive a boat 250 feet long faster, the breadth of beam being the same. The expenses for pilots, mas-

ters, firemen, mates, engineers, deck hands and crew, with the exception of the expense of servants to attend the cabin, whose services are generally about $15 a month, is about the same.

Captain Myers. (396.)

The chimneys are now built much larger in diameter, and much longer than those formerly used on steam boats. The boilers of the boats are less in number and are larger, but the power of the boilers and engines is about the same; and they run with about the same pressure of steam as formerly.

The enlargement of the chimneys gives them a much better draft, enabling them to make steam easier. They also use less fuel now than formerly. The prices of freight and passengers have been diminished.

Captain Green. (407.)

Boats are now made about three times as large as they were, in capacity, when I first commenced steam boating, in November, 1821. The length of boilers has been increased from 12 feet to 36 feet, and the diameter of boilers has been increased from 30 inches to 46 inches. Chimneys have been increased in height from 10 feet to about 80 feet from the waistband of the britches, which is about 4 feet above the centre of the flue; their diameter has been increased from 12 inches to about 52 or 56 inches.

Captain Brickell. (403.)

The boats have increased in size and speed up to the present time, giving greater convenience and capacity for carrying freight and passengers. We have found by experience, that by increasing the height and diameter of chimneys, that we increase considerably the draft, and consequently generate steam easier with a less amount of boiler. The chimneys, therefore, have been greatly increased in diameter and height from what they formerly were; and the number of boilers diminished. We used to have from 6 to 9 boilers, ordinarily, on the larger boats; and now, seldom, if ever, over 5 on the largest class of boats.

Burton Hazen. (426.)

My business is constructing the hulls of vessels. We consider we have made considerable improvement in the model of the hulls of steam boats since 1830, in the form of the bottom of the vessel; making it flatter, fore and aft, than formerly, by which we get a lighter draught of water. Our models are somewhat sharper than they were, at the bow, by which we have increased the speed—and they are sharper at the water line. There is generally an increase of the length of floor, for the purpose of lightening the water draft. The size of the boats has increased, thereby

the capacity for carrying has been increased. We build them likewise of much lighter timber, which increases the lightness of the draft.

John Leatherberry. (429.)

I am a ship and steam boat builder; and I have been engaged in building steam boats for the navigation of the Ohio and Mississippi, and their tributaries, since the year 1827. I have built one ship, in 1848, at Cincinnati.

There has been a great improvement made in steam boats, since the year 1830, on the Ohio. We give our boats more beam and floor, and build them with less timber than formerly; and have increased their capacity about double. The boats that pass through the locks have increased some in length, but are confined to 182 feet, to pass through the canal. There has been a general improvement in all classes of vessels on the Ohio. The length of the boats that do not pass the locks has been increased greatly since 1830.

E. F. Johnston, Civil Engineer. (267.)

The boats on those waters have been steadily increasing in magnitude, and in the height of their chimneys above the water, for several years. And there is no evidence that they have as yet reached their largest dimensions, or their greatest heights of chimneys.

PROGRESSIVE INCREASE IN THE HEIGHT OF CHIMNEYS ON EASTERN BOATS.

John Howell. (185.)

Please state some of the principal boats for which you have recently constructed chimneys and boilers?

Answer. The ocean steamers the Pacific and the Baltic; and the new ocean steamer, now at the dock, to be called the North America; and the river boats, North America and South America, and the Illinois, and others.

Has there, or has there not, of late years, been an increase in the height to which chimneys are carried on steam boats?

Answer. There has been.

Theodosius F. Secor. (189.)

I am one of the proprietors of the Allaire Works, in the city of New York; and am engaged in the business of steam engine building, and general foundry business. I have been engaged in that business for about 25 years. I have constructed the engines and boilers used in the steam boats Hendrick Hudson and the New World, two of the largest class of North River boats. Also of the C. Vanderbilt, and the Connecticut, and the

Commodore, steam boats running on the Long Island Sound. And also of several ocean steamers; among others, of the Ohio and the Georgia.

Have boats of late years, or have they not, increased in length and width, and in the diameter and height of their chimneys?

Answer. They have increased in all these respects. There is no knowing where they will stop as to size, as well as to the heights and diameters of their chimneys.

What was the height of the highest steam boat chimney in existence five years ago, so far as you know?

Answer. So far as I know, it was from 36 to 40 feet.

THAT THE SIZE OF BOATS ENGAGED IN COMMERCE ON THE OHIO WILL CONTINUE TO INCREASE.

Captain Haldeman. (381.)

Question 6. Suppose the Louisville canal to be enlarged, or the falls improved, so as to admit the passage of large boats, what would be the effect upon the dimensions of packets trading from Pittsburgh to St. Louis, and other ports below Louisville?

Answer. The consequence would be that boats would be built much longer than they now are. The packets that now do the business from Pittsburgh to St. Louis, have to pass through the canal at Louisville. But if there was no impediment of that kind there, they would be built as long and as large in every respect as the packets that now run from Cincinnati to Pittsburgh; and boats would be built as large, if not larger, to run from Pittsburgh to New Orleans. The packets from Cincinnati to New Orleans would also be increased in the same manner. The Cincinnati packets frequently load from New Orleans to Pittsburgh, in the winter season; and if there was no obstruction at the falls of the Ohio, boats would be built here immediately from 300 to 350 feet long. Whenever the water is sufficiently high the boats do not pass through the canal, but go over the falls.

To the same effect—

Captain Black,	393
" *Norton*,	394
" *Myers*,	397
" *Green*,	408
Burton Hazen, Ship Builder,	428
John Leatherberry,	430
David Holmes,	656

HEIGHT OF CHIMNEYS ON OCEAN, LAKE, AND EASTERN RIVER STEAMERS.

Joseph Curtis, Inspector, New York. (139.)

Question. What is the height of the chimneys, from the grate bars, of some of the principal boats in this port?

Answer. Some of the North River boats have chimneys 65 feet in height from the grate bars, which were about 9 or 10 feet from the water.

Theodosius F. Secor. (136.)

We have built engines for several lake steamers. I do not recollect the names of all of them. I recollect the Sultana on Lake Erie, whose chimneys are, as near as I recollect, 52 feet high from the upper flues—about 10 ft. from the water. The Ocean, whose chimney was about 54 ft. as built by me; but from information, I believe they were not put up of the same dimensions. Two boats on Lake Ontario, whose chimneys are about the same height as the two last named; but I do not recollect the names of the boats.

John Howell. (175.)

Please state some of the principal boats for which you have recently constructed chimneys and boilers.

The ocean steamers—the Pacific and the Baltic, and the new ocean steamer, now at the dock, to be called the North America; and the river boats North America and South America, and the Illinois and others.

What is the height and diameter of the chimneys of the several steamers you have named?

The Pacific's chimneys, from the top of the horizontal flues, is between 67 and 68 feet high, and the diameter, 9 feet. That of the Baltic is about the same. That of the ocean steamer North America, as near as I can recollect, is 57 feet high and 54 inches in diameter.

Do you suppose the chimneys on the Baltic and the Pacific could have been carried higher with advantage, without increasing their diameter? and state your reason for that opinion.

I have no doubt that increasing the height of those chimneys would have increased the draft. *By increasing the draft, we do not require so much furnace and fire surfaces;* but it is inconvenient to have a smoke pipe on board of a sea steamer very tall, on account of storms, and being in the way of the rigging. Judging from the size of these chimneys, and the sizes of those I have lengthened, I should think those of the Pacific and Baltic might have been increased in height 25 or 30 feet with advantage to the draft.

Charles W. Copeland. (*Defendant's Witness.*) (237.)

Question. Please state whether you are the Engineer who constructed the engines of the Baltic and the Pacific, two of the Collin's line of ocean steamers?

Answer. I am.

Question 2. Please state what are the dimensions of those chimneys; and whether they furnish those boats with sufficient natural draft; and whether they use blowers on these boats; and if not, why blowers are not used?

Answer. The chimneys of those boats are 9 feet in diameter, and are something like 70 feet high from the top of the flues, or 45 feet from the upper deck. There is but one chimney on each boat. The natural draft is very good, though not as strong as I have seen on other vessels using natural draft only. They do not use blowers. One reason why they don't use them is, that the use of them makes a hotter fire-room, the fire-room of those boats being in the hold. Another reason is, that it is a great deal of trouble to take care of the blowers, which has as much influence as all the other reasons combined; for the Engineer's time is sufficiently employed at sea, where his time is more occupied than on the river boats. Another objection, with me, to the use of fan-blowers on ocean steamers, would be the risk of fire.

HEIGHT OF WESTERN PACKET CHIMNEYS
BEFORE THE ERECTION OF THE WHEELING BRIDGE.

Louisville and Cincinnati packet *Pike*, (*Walworth's Rep.* 461.) 69 feet.
Louisville and Orleans packet *Magnolia*, (461.) 79 "
Pittsburgh and Cincinnati packets,
Cincinnati, built at Cincinnati in 1845, (*Walworth's Rep.* 442.) 84 feet.
Hibernia No. 2 " Pittsburgh, 1847, (*Orig. Rec.* 202, 247.) 72 "
Brilliant, " " 1848, " " " " 71 "
Messenger, " " 1849, " " " " 75 "
Telegraph No. 1 " Louisville, 1849, (*Walworth's Rep.* 43.) 80 "
Telegraph No. 2 " " 1849, (*Walworth's Rep.* 703.) 79.8 "
Pittsburgh and St. Louis Packets, (*Orig. Rec.* 354, 355.) 60 to 75 ft.

Captain Klinefelter.

"The J. M. White, Grand Turk, the Meteor, St. Louis, Cincinnati, and other boats, have chimneys about as high as those of the Hibernia No. 2; and they ran on the Ohio river prior to 1847."—*Original Record*, 168.

Captain Sparhawk.

"The height of the largest class of steam boats running to St. Louis, are 75 to 82 feet from the surface of the water to the top of their chimneys.

Their pilot-houses are from 45 to 51 feet from the water."—*Original Record*, 128.

Captain Mason.

"There are boats below the falls, and on the Mississippi river, such as the Peytona, and others of that class, whose chimneys are larger and taller than the chimneys of the Pittsburgh and Cincinnati packets."—*Original Record, page* 408, *answer* 6.

The Louisville packet chimneys range from 75 to 95 feet high.—*Walworth's Report*, 701.

Captain Sturgeon's new packets, built at Louisville, to run thence to New Orleans and St. Louis, have chimneys over 7 feet diameter, 95 feet high.—*Walworth's Report*, 538.

WEIGHT, SIZE AND COST OF PACKET CHIMNEYS.

Alexander Irwin. (66.)

Question. Were the engines and machinery of the Keystone State constructed at the shop where you are employed?

Answer. Yes.

Question. Give the height and diameter of her chimneys?

Answer. They are 3 feet in diameter, and 52 feet long from the hinges at the hurricane deck.

Question. Was she provided with machinery to lower her chimneys, on the Telegraph plan?

Answer. Yes.

Question. Describe the size of her hinges, and how made?

Answer. They are cast iron, and reach about one-third around the chimney; that is about five feet; and are from 12 to 14 inches wide up and down; there is one hinge on each chimney; they are secured by bolts of $\frac{5}{8}$ths of an inch through the hinge and chimney, and through a piece of boiler iron as a stay inside of the chimney.

Question. What is the weight of the chimneys above the hinge?

Answer. About 4000 pounds for each chimney; the iron is about 68 pounds to the sheet, and there is as much as 800 pounds of other iron.

Captain Thomason. (535.)

The weight of each chimney, from the top of the britching, is about 4000 pounds; and the weight of the britching and casing, &c. for each chimney, I should think, would be about 2000 pounds, or more.

Question 5. What is the cost of a pair of chimneys, such as those upon the new Magnolia, including the britching?

Answer. About $1000; or $500 for each chimney.

THE COST AND INCONVENIENCE OF APPARATUS AND EXPENSE OF LOWERING PACKET CHIMNEYS.

"The testimony also shows that, in addition to the cost of preparing the chimneys for lowering, including the greater thickness of iron required for chimneys which are to be lowered, such chimneys will not last more than half as long, or two-thirds at the extent, as chimneys which are permitted to stand during the life of the boat. That life is very short on the western waters; being not more than five years, upon an average."—*Commissioner's Rep. xxxv.*

Reuben H. Miller. (90.)

We charged the owners of the Cincinnati between $350 and $400 for the difference in altering the chimneys so as to let them down, over the original contract price of building the engine; the guy rods and rods for stiffening the chimneys is included in this sum, but not the apparatus for lowering.

Daniel H. Stone. (651.)

What was the cost of the apparatus and rigging for lowering and raising the chimneys of the Keystone State, including the hinging, in order to pass the Wheeling bridge; exclusive of the perpendicular bars inside of the chimneys to stiffen them?

It was $359,61 exclusive of the labor of the hands on board of the boat, and the superintendence. I should think the whole extra expense of the rigging and apparatus for raising and lowering would be at least $400; exclusive of the bars for stiffening the chimneys, and the extra weight of iron for the chimneys themselves.

Captain Dean. (85.)

Where does the captain, or other person in command of the boat, usually stand when on his watch?

On the forward part of the hurricane deck.

Do the derricks and other machinery used in lowering chimneys interfere with the captain in the discharge of his duties?

They do. We have to go across them; and they are so placed that it is inconvenient to get either over them or under them. If they were so elevated as to allow us to walk under them, they would prove an obstruc-

tion to the pilot in looking out; and they cannot be lowered, because they rest on the sky-light.

Col. Long. (556.)

The prime cost of a steamer of the class under consideration, inclusive of her equipments, furniture and outfit complete, may be estimated at $45,000.

The period through which her appropriate operations may be extended, on the Ohio, will not exceed five years; out of which the number of days in actual service will not exceed 200 per year, or 1000 days for the entire period of its service.

The daily cost of operating with such a boat, interest on prime cost, deterioration and decay of the boat, repairs of all kinds, fuel for engine, wages and subsistence of officers, hands, cooks, attendants, &c. and all other expenses incident to working the boat, can not be estimated at less than $200 per day, or $8,33 per hour.

The delay occasioned by the necessary loss of heat in the furnace, lowering the chimney switches or slides, passing the bridge at a slow speed, readjusting the chimneys, and rekindling the fires, can not be estimated at less than one hour in the aggregate. Hence the outlay on account of each passage under the bridge, when the height of the chimney must be reduced by lowering, will virtually amount to at least $8,33 for each passage; on the several accounts above considered. To this expenditure may fairly be added nearly an equal sum on account of lost time to the passengers and freighters; making the entire sacrifice on account of the delay equivalent to at least $16 for each trip under the bridge in high water.

The sacrifice will be enhanced very materially in the event of accidents in raising and lowering the chimneys; especially in windy and stormy weather, in which the apparatus, hinges, &c. are liable to be ruptured, and the chimneys to be deranged and mutilated in such a manner as to require tedious and expensive repairs before the boat can proceed on her voyage.

Captain Hite. (589.)

To prepare every thing and to lower and raise them and to secure them to their places, would take usually from an hour and a half to two hours.

Charles Stone. [94.]

We have had to lower our chimneys on about two-thirds of her passages.

Reuben Miller. (88.)

The Cincinnati cannot go under the bridge without lowering her chimneys in any stage of water when she can run; they will therefore have to be lowered twice a week when the boat is running.

METHOD OF LOWERING CHIMNEYS TO PASS THE WHEELING BRIDGE, AND LIABILITY OF STEAM BOAT EXPLOSION.

Jacob Hezlep, Captain of Telegraph. [85.]

Describe the manner of using the machinery for lowering the chimneys?

In going down the river, I would commence, some five or six miles above the bridge, to slacken the fires, in order to avoid smoke; and not have too much steam on hand at the time of passing the bridge. Then I would pull the chimneys back as far as in my judgment I would think sufficient to pass the bridge, according to the state of the water; sometimes they would have to be lowered 10 or 15 feet, and sometimes lower—I mean, pull them back 10 or 15 feet, which would lower the chimney some 3 or 4 feet. We come down within 500 or 600 yards of the bridge, and then round to—head the boat up stream; then we get a line out to a tree, and then drop down so we could see how far to lower the chimneys, and then drop under the bridge stern foremost.

Edwin F. Johnston, Civil Engineer. [267.]

If a steam boat was required to stop for a time, in order to let down her chimneys in passing under a bridge, would or would not such stoppage and starting again, increase the danger of explosion?

I think it would.

If a steam boat should arrest her rate of progress, by letting off steam in order to let down her chimneys, so as to pass under the bridge, would this or would it not increase the danger of explosion; as compared with a continuous running of the boat, without such interruption, in going down the river?

It would.

Would you, or would you not, consider the letting down, in whole or in part, of such chimneys as you saw on the Pittsburgh steam packets, in order to pass under a bridge, to be attended with inconveniences, delay, or danger; and would the danger, where the whole chimney was let down, at the hurricane deck, be more or less increased where bituminous coal was used instead of anthracite?

In reply to the first part of the question: I think the letting down of the chimneys, either in whole or in part, would be attended with inconvenience, delay, and danger. In reply to the last part of the question: so far as the greater amount of smoke from bituminous coal, as compared with anthracite, tends to obscure the vision of those who are navigating the vessel, the comparative danger, resulting from the use of bituminous coal, will be greatest. I take it for granted that it would not be prudent to stop the draft of the chimneys entirely, during the process of letting them down and raising them again.

DANGER OF LOWERING CHIMNEYS.

"The very elevated as well as large chimneys used upon the Pittsburgh and Cincinnati packets, and other boats of that class, can not, certainly with any facility or safety, be lowered by hinges at the tops. They are, therefore, obliged to lower them at the hurricane deck, by the means of a derrick. The weight of the parts of the two chimneys which must be let down, upon these large boats, is estimated by the witnesses to be from three to four tons. This enormous weight hanging over the cabin, or rather over the berths of the passengers, in the process of lowering, would probably prove disastrous in the extreme, if by any accident the chimneys should come down by the run; which is very likely to occur, from the carelessness or stupidity of the green hands that the owners and officers of western boats are so often obliged to employ.

"The danger of lowering chimneys to pass the Wheeling bridge, in passing down the river, is very much increased by the velocity of the current between the head of the island and the bridge, when the water at Wheeling is very high; unless the boat is subjected to the delay of slackening her fires, stopping her engine, landing her above the bridge, and dropping her down stern foremost, by a warp."—*Commissioner's Rep. xxxv.*

Professor Renwick. (102.)

What do you think of the convenience and safety of a hinged top or a sliding top, on chimneys of 60 to 90 feet in height, and from 4½ to 5½ feet in diameter, and weighing one or two tons each?

I should think a hinged chimney troublesome and inconvenient to manage; and do not see how it could be lowered without either extinguishing or very much lessening the fires. I should think a sliding chimney a somewhat better arrangement; but it would require machinery and an application of sufficient power to raise and lower it. Either would probably require an additional number of hands to manage them.

Professor Byrne. (117.)

Do you or do you not think a hinge top, or a sliding top, to a chimney of 50 or 60 feet in height above the upper deck, and from 5 to 5½ feet in diameter, would be a convenient, a safe, and an economical adaptation?

I think it would be any thing but safe or economical. I have never seen them used in boats having chimneys more than 20 feet above the deck, and even then with great inconvenience.

Do you or do you not know, or can you or can you not suggest, some safe, convenient, economical adaptation, by which the whole of a chimney, of that height, above the hurricane deck, could be lowered?

I do not know of any mode by which it could be lowered and put up again with safety.

John Howell, Engine Builder, New York. (179.)

Do you or do you not think a chimney of 70 or 80 feet in height above the hurricane deck, and 5 feet 6 inches in diameter, could conveniently, economically and safely be furnished with a hinge near the top, to let down a portion of it, or a hinge at the hurricane deck, to let down the whole of it; or a sliding top, to let down a portion of it?

I do not think such a chimney could be conveniently lowered in either way. To let it down either way would require tackle purchases, which would be complicated; and it would require labor to use them. I have built chimneys to be let down by a slide, and have seen them lowered in that way. I have also seen them lowered by hinges at the hurricane deck; small chimneys. But to lower large chimneys, in that way, I consider impracticable.

Professor Locke. (445.)

Suppose steam boat chimneys to be from 5 to 6 feet in diameter, from 30 to 50 feet high above the hurricane deck, and weighing from 1500 to 2000 pounds each. What do you think of the convenience and safety of raising and lowering such chimneys, by any mechanical contrivance, in order to pass a bridge?

Answer. The lowering of such chimneys, it is quite evident, would be inconvenient; and the machinery required for the operation, by adding weight, and occupying space, would encroach on the compactness required in the Ohio boats. To what extent these operations would be inconvenient and unsafe, I am not so able to judge as men who are used to similar undertakings. I have seen the machinery for raising and lowering smaller chimneys. My opinion is, that the inconvenience would be very great; if it would not be incompatible with safety, in the case of large chimneys; especially if they were hot.

Solomon W. Roberts, Civil Engineer. (652.)

State your opinion as to the safety and convenience of raising and lowering such chimneys in dark nights and in stormy weather?

Answer. I think it would be a very inconvenient and dangerous operation; on account of the great height and weight of the chimneys, and the difficulty of handling them in dark nights or in high winds.

Captain Heslep. (44, 45.)

I consider it very dangerous in lowering those large chimneys. The reason I consider it dangerous is, that if any part of the machinery should

break, the chimneys would fall on to the deck, and probably through it. I speak of the hurricane deck. Not only that, but we have on this river a very indifferent set of men. One-half of them are the greenest kind of Irish and Dutch—more than one-half of them: if you should tell them to hold on, they would be as likely to slack up the rope as to hold on. Another reason is, the men are afraid; you cannot get them to stand close enough to the chimneys to keep them from swaying about when they are lowered or raised. This is the case with the officers, as well as with the men of the boat—all who are concerned in taking the chimneys down. If we should get to the bridge about the time a storm was coming up, or in windy weather, it would be almost impossible to lower the chimneys, in some such storms as we have. The danger would be increased in stormy weather, but not in foggy weather—we never run in foggy weather. In dark nights the danger would be increased. I have seen winds and storms on this river when it would be almost out of the question to lower chimneys.

Question. Is the pilot exposed to any danger in lowering the chimneys?

Answer. Yes; if any part of the machinery should give way, the chimneys might fall upon the pilot house and endanger his life.

Question. Is the rigging subject to become rotten and weak?

Answer. It is very liable to rot and become weak; and that would expose the men to danger from an unexpected fall of the chimneys.

Wm. Peppard. (62.)

Any part of the machinery giving way, or the men misunderstanding the order of the captain, might let the chimneys fall, and break the whole hurricane deck in. I believe, if our chimneys fell, they would break in the boat to the boilers. I consider there is very great danger to those engaged in lowering; they are placed in such a situation that they would be in danger if the chimneys fell.

Reuben Miller, Engine Builder. (85.)

It is attended with a good deal of labor, and it is at all times dangerous; in windy weather and dark nights exceedingly so, both to men and boat.

Captain Charles Stone. (94.)

Do you find the operation of lowering the chimneys dangerous, or otherwise?

Answer. I do consider it dangerous to lower chimneys. In the first place, all rigging and iron work is liable to break; and when we get our chimneys at an angle of 45, less or more, it begins to bear very heavy upon the iron and rigging of every description; if any thing should then give way, it is hard to tell what might happen, or what the danger might be.

What danger is there to life, or to the vessel?

Answer. I think there is great danger to both. If any thing should break or give way, and the chimneys should fall on the deck, I do not know whether it would smash through or not. If people were about there, and the chimneys should fall on them, it might kill them. People walk about every where on the boat.

How many persons are required to be engaged in the lowering of your chimneys, and where are they stationed?

Answer. There are from 16 to 24; we work all the men that are not engaged at the time. They are stationed on the hurricane roof and on the main deck; about two-thirds of the men are on the hurricane roof, at three different places, and one-third on the lower deck, in one place, occupying a space of 16 feet around the capstan.

Captain Haldeman. (363.)

The lowering of the chimneys of steam boats is attended with more or less delay, in order to pass under a bridge. Very often the chimneys get moved out of their places, or bent, by touching the bridge, and give much trouble to fix them so that they can be shipped. I have known them, in attempting to raise or lower their chimneys, let the top fall against the standing part, by the giving away of the fixings, and to mash both parts.

I saw, last sping, the top of a chimney fall at the canal bridge, from its touching against the arch of the bridge one side of the centre. It is difficult, in windy weather, to keep the boat under the centre of the arch. The part of the chimney which fell, mashed a part of the hurricane deck in, and came near killing two or three persons. Much precaution has to be used, particularly at night, in raising and lowering these chimneys; for there is always more or less danger of their falling, and the lives of the crew are endangered.

Captain A. Norton. (394.)

It is attended with some danger; and they will not last so long by one-fourth, I should judge. It also occasions delay. A boat ought to be landed and made fast, before the chimneys are lowered. In my opinion, they ought not to be lowered while the boat is under way.

Captain Myers. (397.)

It is attended with delay, and danger, and expense. The danger in lowering and raising the chimney is, that the iron at the fastenings and the hinges might give way, and let the chimney fall and kill the passengers, by breaking the deck of the boat in. I have sometimes, in passing under the bridge of the canal at Louisville, been delayed two hours; and I have been

five or six hours. It is difficult to pass under the bridge if the wind is blowing. I cannot tell what the expense is. I would sooner give $50 a passage than be bothered with the bridge. It injures the chimneys, more or less, every time they are lowered and raised.

Captain Brickell. (434.)

There is considerable danger. In two or three instances, in my experience, the chimneys entirely fell down, in consequence of some of the machinery giving away. Sometimes the whole chimney would fall, mashing whatever it fell upon. This has happened on my boat twice. I have been where it has happened on other boats, but never saw it happen. The effects of it is very visible on the boat I now command. I do not know of any person being hurt by the lowering or raising of chimneys; but still there is danger, to persons on board, as well as to the boat.

Captain Green. (40.)

It is both attended with danger, expense, and delay. The danger is by the falling down of chimneys, which endangers life and limbs. The expense consists in the first place in fitting the chimneys to be lowered, and the time consumed in lowering them and raising them. The lowering and raising of chimneys consumes from one to three hours at the canal.

Captain Ross. (413.)

It is always attended with expense to create an apparatus to lower them with. In lowering the chimneys, there is always danger of loss of life and limb, let them be high or low. The higher the chimneys, the greater the danger, and the more impracticable it is to get them up or down. It is a dangerous operation to let down these low chimneys which pass the canal.

Captain Whitten. (418.)

With all the improvements that have been made for the raising and lowering chimneys, there is danger if any part of the apparatus gives way. And the danger is in proportion to the weight and size of the part of the chimney lowered. There is expense.

Edward Shields, Engine-builder, Cincinnati. (420.)

There is great danger of loosening the tops of the chimneys from where they are hinged by lowering them, owing to the persons doing it having no control of them, they being so far out of their reach. It involves the safety of the chimneys, and the expense is great from the detention of the boat.

Theodore Seowden, Engineer. (424.)

It is attended, I think, with danger; and I always avoided assisting in the operation if possible, particularly in windy weather: for I considered it was dangerous to life to be raising the chimneys when the weather was either rainy or windy, for the reason that when it was windy the boat could not be kept steady, but had a tendency to roll, which made it a very difficult matter to get the chimneys to shut down to their places at the hinge. The tops often break loose, in windy weather, from the machinery and fall; and in rainy weather, the foothold of the men is uncertain. And it is difficult to get men to work in rainy weather, supporting the heavy weight of the chimney. The expense is owing more to the delay than to any other expense attending it. It happens many times, in the process of lowering or raising the chimney, the guy ropes or tackle give way and break the hinges, and the top of the chimneys fall. The breaking of the hinges and the falling of the chimneys, and the strain in hoisting or lowering them, shortens their duration.

Captain Thomasson. (536.)

It would be attended with danger, expense, and delay, in every particular. I have not been accustomed to lower chimneys, but I know all about them. I have selected the iron for my present chimneys, for the purpose of having them last the lifetime of the boat: whereas, if we had to lower them, they would have to be renewed before the boat was half worn out; because such heavy chimneys are more or less injured every time we lower them.

Captain Sturgeon. (537.)

It is attended with considerable delay and expense. It requires a great deal of care to prevent your chimneys from falling.

John Ferguson, Pilot. (650.)

I have frequently been on watch and noticed the process of raising and lowering the chimneys to pass the Wheeling bridge. In my opinion, the process is always attended with danger to the pilot and others. If any of the rigging should give way, or if the iron should be bad and give way in frosty weather, or if anything should slip when there was sleet and ice on the deck in stormy weather, it would necessarily be attended with danger. The pilot, the crew, and passengers would all be in danger from the falling of the chimneys.

**John T. Brooks.* (400.)

Question. State whether you have experienced difficulty and delay in passing that bridge with steamboats?

Answer. There is considerable difficulty in passing the bridge, but not much delay when managed properly. The difficulty is in raising and lowering the chimneys. The way they are fixed for lowering, it requires all the hands on deck. We once attempted to lower at the head of the canal, and let the chimneys fall entirely down through carelessness. It was done by holding on the line that the chimneys were cased down by, and at the same time pulling upon the line attached to the top of the chimneys, until the prongs of the fork above the hinge of the chimneys were spread so as to break the guys and let the chimneys fall; and they all went on to the hurricane deck together.

**Isaac Coffin.* (504.)

I have seen it take more time when the chimney got out of round, so that it was difficult to make the upper part fit on to the standing part when raised. It is a common occurrence for the chimneys to get out of round in lowering, if they are not well fixed. I do not know that the wind would have that effect; but the iron in the chimneys gets tender after two years, and they are apt to get out of order if they are not supported.

**Cassius B. Sandford.* (514.)

Is the operation of lowering and raising chimneys equally safe and convenient in the night as in the day time, and in all kinds of weather?

I should think not. It would not be as safe or convenient to raise and lower chimneys when the deck was covered with ice, as it would when it was dry. They cannot be lowered or raised so conveniently when the wind is blowing hard, as they can when it is still.

What danger would occur if the poles, or the fastenings at the top of the chimney, were to give way?

If the hinge was a good one, there would be no danger; the top piece would fall down by the side of the standing part and remain there, as I have had it to do. If the hinge should give way, the top of the chimney would fall to the deck, and injure the deck more or less. If the piece falling should strike any person in a vital part, it would kill him.

Is the danger and inconvenience of lowering chimneys increased by the weight and size of the piece to be lowered, in your estimation?

Certainly it is.

**Jacob Beckwith.* (545.)

Question 23. Do you consider that there is perfect safety in lowering such chimneys at all stages of the water, and in all kinds of weather?

Answer. I do not exactly think there is perfect safety in any operation managed by mechanical power.

Do you consider it equally safe in all kinds of weather, on the Ohio river?

Answer. No. It is not equally safe in all kinds of weather.

Do you consider it any trouble to the officers or crew, to lower chimneys?

Answer. It is labor.

Do you know what expense it is, if any, to prepare the chimneys for lowering?

Answer. I do not know the expense.

John B. Shallcross. (628.)

Answer. It would be considerable trouble to lower them down and raise them again. The risk is, that something of the lowering apparatus may give way and the chimneys fall and break to pieces; and they might break through the hurricane deck. The labor would require a portion of the crew of the boat for a short time.

ARTIFICIAL MEANS, SUCH AS FAN BLOWERS, STEAM BLOWERS, STEAM-JET, CANNOT BE SUBSTITUTED FOR THE NATURAL DRAFT OF HIGH CHIMNEYS.

Professor Renwick. (100, 101, 103.)

What do you think of the fan blower, as a substitute for natural draft; as to regularity of action and ease of management?

The fan blower is an excellent substitute for natural draft, where the fuel is difficult of ignition, as in the case of anthracite coal; or where the fuel applied to generate steam does not yield a long flame by natural draft, as in the case of coke and charcoal. The latter reason also applies to anthracite coal. I have never seen it used with either bituminous coal or wood. But I think that it would rather tend to diminish the quantity of steam obtained by the combustion of those descriptions of fuel, by throwing too great a body of cold air into the furnace. It will also cause a great waste of those descriptions of fuel, by driving off light carbonaceous matters, and by forcing the flame into the chimney. I should infer that the fan blower was not advantageously applicable to the boats on the Ohio river, for the reasons I have just stated.

Does or does not the running of the fan blower consume a part of the power that would otherwise be used in propelling the vessel?

The use of the fan blower does require the application of a part of the power of the engine, which, if it could be obtained independent of the blower, could be used in propelling the boat. A good engineer would never use a blower, unless he, by its aid in promoting combustion, obtained a greater increase of the power of his engine than was necessary to drive the blower.

I have seen them used in many cases where there was an obvious loss of power instead of a gain, having regard to the quantity of fuel consumed.

In the exhaust steam-jet the steam from the eduction valve is carried by a nozle into the middle of the chimney, which it enters at a point above the level of the horizontal flues. It can only increase the draft when the velocity of the exhaust steam is greater than the velocity of hot air due to the height of the chimney, or when the steam is hotter than the air in the chimney. I should therefore consider that, for the first reason, its advantage would cease in chimneys more than 20 or 30 feet in height, in which the velocity would be greater.

To what description of steam mechanical contrivances is the use of the steam-jet chiefly limited?

As far as I know, it is only used in locomotive engines.

E. F. Johnson, Civil Engineer. (225.)

The fan blower is not a mode so well suited for producing draft, in the burning of bituminous coal, as the natural draft by a chimney. Its use on board of steam boats is inconvenient, and it is disagreeable from the noise it usually produces. And in operating the blowers, a certain amount of power must be provided, which is not requisite with the natural draft.

Daniel Carpenter, Engine Builder, New York. (132.)

What do you think of the fan blower, as a substitute for natural draft, as to regularity of action and ease of management?

I do not like a fan blower as well as a natural draft. One reason is, that if the force of the blower is much above the natural draft of the chimney, sparks and smoke will escape whenever there are any apertures about the furnace. And another is, that the blower forces the flames stronger against the boiler immediately over the grate. I have found boilers, where blowers are used, not to last as long by 30 per cent. as boilers using a natural draft. It requires more power to drive the blower; and they being run at high speed, they are expensive to keep in order. I have seen wood tried a number of times, and they never could succeed in burning it with a blower. The sparks and smoke would escape, so as to become dangerous in causing fire.

Joseph Curtis, Steamboat Inspector, New York. (137.)

What effect has a fan blower on the duration of a boiler?

Destructive. They were introduced for the burning of anthracite coal, and are only adapted to that kind of fuel. They are not adapted to wood or bituminous coal. The inducement for the introduction of fan blowers was, and is now, to enable them to use less boilers, both as to fire surface

and contents of water, and to enable them therewith to carry higher steam than they could procure by ordinary draft. This use of the blower, to many of our boilers, has enabled them to carry high steam upon a low pressure boiler. When I say high steam upon a low pressure boiler, I mean steam over 30 pounds. Many low pressure boilers carry steam as high as 60 or 70 pounds—as the engineers have informed me. The objections we have to blowers, and the public are becoming of the same opinion, and abandoning them, are these: They are expensive, and require considerable additional machinery, inasmuch as they require a separate engine for each blower; they are very annoying to passengers, on account of the noise—destructive to the boiler, in the furnace part thereof—and in most cases they choke up the flues by the ashes and particles of coal carried to the extreme part of the flues, so much so in many boats, as to require the flues to be swept every 12 hours. Another objection that we find very common, is, that the firemen are tempted to, and do put coal into the furnace to excess. The fan blowers are also hazardous, in setting the boat on fire, an instance of which occurred in the summer of 1849, as I was informed by the engineer, and the boat was burned. She was owned by Mr. Stevens. The draft, as the engineer said, blew the door of the furnace open, and the blaze came out. I have, in the course of my official visits, seen three or more boats that had been on fire in their engine rooms, and was informed that it was caused by starting the fan when the furnace doors were open. The engineer frequently starts the fan blower, not knowing the furnace doors are open. The reason is, his position is such that he cannot see the furnace doors when he starts the fan engine. In many instances, the engineer's station at the working engine of the boat, is 20 feet from the blowing engine. Another objection is, the blower brings the gas out of the furnace doors, and the doors burn up.

Does or does not the fan blower consume a portion of the power?

It does.

Joseph Howell, Engine Builder, New York. (179.)

What effect has the exhaust steam-jet on the duration of a steam boat chimney?

It destroys it, by oxydizing or rusting the inside of the chimney. I think the chimney would not last more than half as long where this jet is used, as it would when it is not. The chimneys of boats, when they are 3 feet in diameter, generally have about No. 15 or 16 iron. Those that are smaller are built with thinner iron, and those that are larger with iron that is thicker; those that are built with No. 14 iron will last without the jet about four years on an average.

Professor Byrne. (116, 117.)

What do you think of the fan-blower as a substitute for natural draft; as to regularity of action and ease of management?

The fan-blower is inferior to the natural draft, with respect to regularity and ease of management. The fan-blower takes additional machinery. I would prefer the natural draft in point of economy. The fan-blower is not as well adapted for bituminous coal as it is for anthracite.

Is or is not the exhaust steam-jet an efficient substitute for natural draft, with a chimney of over 30 feet in height; or where the stroke of the engine is long, and the consequent intervals between the jets long?

It would not be an efficient substitute. The steam might condense in the chimney, create a vacuum, and become detrimental to the draft; especially when the stroke was long.

To what descriptions of steam mechanical contrivances, is the use of the exhaust steam-jet, in Europe and in this country, so far as your knowledge extends, chiefly limited?

Chiefly to the locomotive engine. The use of it even in the locomotive is frequently detrimental; because it drives small coals and sparks out of the top of the chimney.

Professor Locke. (446.)

I have seen the fan-blower in operation, on the eastern boats, for the last four or five consecutive years, on my journeys there; and for burning anthracite coal. When the fan blast is made to enter a chamber, communicating broadly with the grate, as in the steam boat John H. Stevens, on the Delaware, it operates by a general pressure, closely resembling natural draft. But there are several drawbacks, in point of economy: 1st. The cost of the machinery, and its liability to get out of repair; 2d. Its weight, and the space it occupies; 3d. It is kept in operation by steam, at the expense of heat and motive power; 4th. It is liable to injure the boilers and grate bars, by burning, in consequence of the excessive heat. And where it enters the furnace without a broad chamber, it injures them, by concentrating the heat at particular points.

I know the general manner in which the steam-blower is used, although I have no practical personal knowledge of its advantages or disadvantages. Steam is lighter than air at the same temperature; and the introduction of it into the flues may diminish the specific gravity of the column of air in the chimneys, and thereby aid the natural draft. If the steam used be taken out before it has passed the engine cylinder, it will increase the draft, by impulse communicated to that column of air; but at the same time it would consume motive power, by abstracting steam from the boiler. The exhaust steam-jet is not liable to the objection of consuming motive power.

In point of principle, it would be anticipated that both of these modes of introducing steam into the flues or chimneys would diminish, materially, the durability of these parts, by causing rapid oxydation or rusting. The artificial draft is the more needed in burning anthracite coal, than in burning bituminous coal or wood, from the greater compactness of the carbon of the anthracite coal, and the consequent difficulty of bringing it into a state of ignition. It requires a stronger draft for that purpose.

Col. Long. (554.)

These means, and especially the fan blast, have been employed for the purpose of increasing the draft of steam boat chimneys on the Ohio River; but have generally, if not invariably, failed to give satisfaction, wherever they have been employed on board of boats navigating the Ohio, and other western rivers. The reasons of their failure, probably, have never been adequately known; at any rate, they appear never to have been satisfactorily explained. The fan blast has a manifest tendency to accelerate the oxydation and corrosion of the grate bars, boilers, flues, &c. with which it is used; while it appears reasonable to suppose that the steam-jet has a similar tendency with respect to the chimney, and the same tendency in a less degree with respect to the grate bars and boilers, by reason of its more equable and uniform action upon these parts.

It is, moreover, believed, that a much larger portion of the inflammable matter of the fuel is driven off without combustion, in the use of the means above considered, than in the use of tall chimneys, to produce an equal, more reliable, and uniform effect. Hence, I have no hesitation in adding my testimony to the experience of others, in favor of a preference for tall chimneys, as the more economical means of producing the requisite draft in the chimneys of western steam boats.

Captain Devol. (55.)

The fan was a nuisance to the boat, from the fact that it made a very loud noise when blowing; and the chimneys being short, it blew out an unusual amount of soot from the coal, and of sparks from the wood. This, I presume, was the cause why the Clipper had a dirtier and blacker appearance than any other boat in the line. Three other boats had used them, but they did not answer.

Captain Peppard. (63.)

I consider they are dangerous—calculated to burn the boilers and heat the britches and chimneys too much—and also dangerous in throwing sparks and fire.

Alexander Irwin, Engine Builder. (68.)

Are you acquainted with the fan-blowers; and if so, state your opinion as to their adaptation for procuring draft?

They will make more draft, and injure the boilers more, than the steam-blowers.

Have you noticed that boilers using the fan-blowers require more repairs than others?

They do.

Samuel Young, Engineer. (61.)

Is the fan-blower subject to get out of order?

It requires a good deal of fixing; it requires as much fixing to keep it in order as one engine.

Reuben Miller, Engine Builder. (88.)

Have you seen the operation of fan-blowers upon the boilers of boats.

I have. I consider it has a tendency to throw an unusual quantity of heat on a particular point near the bridge wall, and weaken the boiler. We used the fan-blowers on the engines at our works, and abandoned them for that reason.

Theodosius F. Secor, Engine Builder, New York. (188, 189.)

There is no advantage in having a blower as a substitute for natural draft, but a great many disadvantages. One disadvantage is that more coal is consumed in proportion to the steam raised; and another is that they destroy the boiler. More coal being burnt in the same space of time, of course it will create a greater amount of heat; and of consequence it will destroy the boiler. The destruction of the boiler caused by the blowers is mostly limited to the furnace part of the boiler.

John Howell, Engine Builder, New York. (177, 178.)

We prefer natural draft to that procured by blowers. The blowers take some power from the engine, to drive them; and they occupy room on the boat, and create an unpleasant noise, and trifflingly increase the weight upon the boat. And from the intensity of the heat which they create in the furnace part, they are much more liable to burn the boilers than the natural draft: that intense heat being communicated to particular parts of the furnace, and not diffused generally over its whole extent. The natural draft diffuses the heat more generally over its whole surface. The use of the blowers is not so economical in the consumption of fuel as the natural draft, because fine particles of the coal, unconsumed, are forced off, either by the sharpness of the draft, or the intensity of the heat, or both; and are carried off through the chimney.

Captain Haldeman. (386.)

State whether or not you consider fan-blowers a good substitute for high chimneys; what is their cost; and whether their use consumes any of the motive power?

I should not be willing to use them entirely as a substitute for high chimneys. They cost about from $400 to $500 a pair, in Philadelphia; and the small engine that drives these fans costs about $500. The power that it takes to drive the small engine is not very great. The steam is taken from the general supply of the boat, to drive this small engine. The doctor might be driven by this small engine; but I have never seen the doctor thus driven. These fans, when introduced into New York, were found to burn the boilers out.

Captain Devol. (58.)

How is the STEAM-BLOWER found to operate, and what is your opinion of its utility?

It increases the draft, but is expensive in keeping it in repair; it is liable to accident, for the holes in the short pipes increase in size, and consequently it takes more steam from the boiler, and creates more draft than is necessary; and it boils up the water in the boilers so as to burn more fuel and endanger the boilers from collapse, thereby requiring more vigilance in watching the boilers to prevent explosion; there is not that regularity there is in a natural draft; the engineer has to be constantly watching the valve that lets the steam into the pipe which leads from the steam pipe.

Alexander Irwin, Engine Builder. (68, 69.)

Steam-blowers will increase draft, I think, and will spoil the boilers; they make an undue proportion of heat under one part of the boiler and not under the other parts, as they don't carry the flame along, and thus heat one part of the boiler more than another. After the boat is under way I do not think the steam-blower is of much account; I would rather have the steam in the boilers than have it used on the blower. The steam-blowers injure the boilers and get burned up; and when the valve is first opened they throw in water and wet the flue. And after they are started the loss of steam is equal to the benefit of the increased draft.

Captain Dean. (19.)

What was the effect of the steam-blower?

It was very injurious to the boilers; and the pipe across the after end of the flues would burn off about as often as once a week; and we were obliged to abandon it, to save our boilers. It burnt the heads of the rivets off on the laps of the boiler at the after end of the grate bars.

Captain Grace. (91.)

We put on the patent steam-blowers, and then thought we obtained about as much steam as before the chimneys were cut off; but we took them off after using them six weeks or two months, because we supposed they were injuring the boilers.

Captain Brickell. (405.)

I have used the steam-blower only for two or three trips on the steam boat Alhambra. I found there was very little benefit to be gained by it; and it had a tendency to carry a great many larger sparks out of the chimneys. We burned wood. Those sparks generally fell on the hurricane deck, and was in danger of burning the boat. The great danger of all boats burning up, is from sparks from the chimneys; and that danger is greatly obviated by increasing the heights of chimneys and their diameters. It is very seldom that sparks go out of these high chimneys; and when they do they are generally carried beyond the boat, by the height of the chimney. The blowers I had would have cost me $150; but as I threw them by, they cost me only $30, the cost of putting them up. There was no benefit to be derived from them.

**John W. Cummings.* (29.)

Were the first blowers taken off?

Yes.

Why were they taken off?

They burnt out the first trip, and were not found useful; but afterwards, at my suggestion, new ones were put on with an alteration, taking the steam from the steam pipe instead of the boiler, and were found to be better.

**George W. Norton.* (38.)

Question. Have you steam-blowers?

Answer. I used them one trip.

Question. What was the effect?

Answer. The effect was I consumed a good deal more fuel; I could not perceive that we made any more steam; we used them with wood, and with wood and coal together.

**Isaac Pulver.* (194.)

Are there any inconveniences attending the use of the blowers?

They are noisy, most of them. There are one or two kinds of blowers, I believe, that do not make much noise; but I have never been on boats where they were used. Some say they burn out the boilers more than natural draft.

*Wm. Mason. (202.)

Do engineers and owners of steam boats that can get a natural draft prefer to use it, and why?

They do prefer to use the natural draft when they can get it. The reason is, the cost of the blower and engine, and the expense of keeping them in repair. Another reason for preferring natural draft is that the blowers are not as good for the boiler as the natural draft, provided they drive them up to a speed sufficiently great to get a draft stronger than the natural draft would be.

*Charles W. Copeland. (203.)

They injure the boilers more; because the heat is more concentrated about the furnace. By the natural draft we draw the air in, by the blower we thrust it in. There can be no fair comparison made from experience; because in using a blower the combustion is invariably much stronger than that obtained by the natural draft, as we have the natural draft in ordinary practice.

*John F. Rodman. (214.)

Question. What are the inconveniences, if any, in the use of the fan-blower on steam boats?

Answer. The room they occupy, their cost, and the expense of keeping them in repair. These are all the inconveniences I know of, either on passenger boats or on tow boats.

*William Stewart. (530.)

I have never tried but three artificial modes of obtaining draft on steam boats. One was the fan-blower, another the steam-blower, and the other the exhaust steam-jet. I have also used the natural draft alone. My opinion is that the steam-blower, introduced into the after end of the flues, is the best. All these modes are used to aid the natural draft. The advantages of the steam-blower are, that it keeps the flues clean, and saves the necessity of cleaning them out in some other way. You can regulate your draft by letting on or shutting off your steam. The fan-blower is preferable to the exhaust steam-jet. I do not think it is possible to use the exhaust steam-jet to advantage on steam boats.

ACCIDENTS AND DETENTION OF PACKETS ALREADY OCCASIONED BY THE WHEELING BRIDGE.

Keystone State, Monday Packet. (92, 93.)

On Monday, 4th March, 1850, after we had left Pittsburgh, in holding a council aboard the boat, we measured the height of our boat to see

whether there was a prospect that we could get under the bridge. From our calculation, we supposed that the water in the river would be from 2½ to 3 feet higher at Wheeling than at Pittsburgh. We supposed there would not be more than 3 feet difference, and at 3 feet we could have gone under the bridge. We came to the conclusion that we had at least 12 inches to spare. When we got there, there was no light at the highest point of the bridge; and we rounded to, for the purpose of finding the place to get under the highest point of the bridge. Ever since that, we have found a light there. We did not consider it safe to go down head foremost. In dropping down, we got as close to the Virginia shore as we deemed it safe to go, for the purpose of getting under the highest point; but we struck about 20 feet from the highest point, towards the Ohio shore. In dropping through, our outside chimney from the Virginia shore struck the bridge, and tore away the entire fastenings of both chimneys except one rod. We broke the outside chimney in two, and broke off the hinge from the inside chimney. The rods tore up the hurricane deck some, but not much. The chimney that broke off fell on to the other chimney, and both were sustained by the single rod that did not give way. We were detained until the next day at 3 o'clock in the afternoon, working all the time with the exception of about four hours. The night was very dark, and we worked at a very great disadvantage. We had at the time from twenty-five to thirty men of our own, including laboring men, engineers and mates, engaged in working at the chimneys, in getting them out of the way and clearing them up. From the the city we got two sheet iron workers, to assist in repairing the chimneys; we also had some blacksmith work done in town, besides the work done by our own blacksmith. Our chimneys were fixed up temporarily, to run to Cincinnati and back to Pittsburgh, which we did. The chimney broken in the middle, we repaired at Wheeling: the chimneys have not since been altered. The pitching, with the chimneys, are sagged, so that they do not stand straight; and in lowering, they lower to one side.

Hibernia No. 2, Tuesday Packet.

We left Cincinnati on Friday, the 9th of November, on her last trip up bound to Pittsburgh, with about 230 passengers in all, when she left Cincinnati, bound to different ports, but principally to Pittsburgh. We had not a great deal of freight on this trip; the principal part of it was for Pittsburgh. She reached Wheeling on Sunday, the 11th of November, about noon. There were 25 feet 7 inches of water in the channel at Wheeling. She did not reach Pittsburgh at her usual time; she was hindered by the bridge. She could not get under the bridge with her chimneys. It was nothing more than a common freshet—nothing more than common high water. The bridge was from 6 to 7 feet too low for her to pass on that

stage of water. We laid the boat up at Wheeling, and shipped her freight and passengers on board the James Nelson for Pittsburgh. The Nelson is a small boat. We can't say what the damage is yet. We paid to the James Nelson for one item, $140 for passengers. Her next down trip was injured by not being in Pittsburgh in time. She did not reach Pittsburgh until 7 o'clock on Tuesday morning. Her regular time for reaching Pittsburgh is from Sunday noon to Monday morning. Judging from ordinary occasions, she was injured in her downward trip $400. One of our chimneys, which was injured in passing the bridge, was taken down, and they are working at it now. If it cannot be put up again, the cost of a new one will be $300. I think it can be put up again."—*Captain Klinefelter.*

"The second obstruction to the passage of the Hibernia occurred day before yesterday, 18th December. We left Pittsburgh about 11 o'clock. * * * We reached Wheeling about 5 o'clock. The water, by the marks on the Wheeling wharf, was 27½ feet. We lacked about 6 feet of getting under the bridge. We found the river falling so slowly, that we should not be able to get under the bridge in less than thirty or thirty-six hours, which would throw us off our regular day and cause us to lose a trip, as we should not be able to leave Cincinnati on our regular day. We leave Cincinnati on the same day every week; and if we miss that day, we have to lay by for a week. We then thought proper to reship our freight and passengers on another boat, and the Hibernia No. 2 returned to Pittsburgh. She will have to lie here until her regular day for going down next week. There will be no regular boat to take the place of the Hibernia, in coming up from Cincinnati to-morrow, (Friday, the 24th of this month,) so that the upward trip is entirely lost to us.

We have lost the receipts of the week, which, at an average at this season of the year, would be about $1600 a week; and it has caused us to lie still, under an expense of five or six hundred dollars. Our present losses are nothing, in comparison to those which will follow from the loss of confidence in our boat. Our friends will not go with us, from the apprehension, on every prospect of high water, that we shall not be able to get under the bridge. We left this, on the day before yesterday, with but nineteen cabin passengers; and I never knew so small a number leave Pittsburgh on a packet boat before. The cause of this, I have no doubt, was the apprehension that this boat would not be able to get under the bridge at Wheeling.—*Original Record*, 173.

Cincinnati, Wednesday Packet. (649.)

We reached the bridge a little after dark. It was a beautiful moonlight evening. I think there was between 4 and 5 feet of water on the bar at Wheeling; but I did not look at the gague-mark. We lowered our chim-

neys at the wharf at Wheeling, low enough, as we thought, to pass under the bridge. We came up to the bridge as slow as we could come; and as we approached it, the other pilot, who was looking out with the captain on the fore part of the hurricane deck, called to me to stop the boat just as the bow of the boat was commencing to pass under the bridge, at the very highest point of the bridge. He told me I had better back the boat. I stopped her as soon as possible; but the chimneys had struck the bridge before I could back the boat. I then thought it would be more dangerous to back her, as the chimneys were so far under, and I went ahead. The chimneys being lowered backwards, would have been torn down by the bridge if I had backed the boat. The captain told me to start the boat ahead; and I told him I had done so. By this time the chimneys had gotten beyond the bridge. I asked them if some of the guys were not broken; the captain and the other pilot said they thought not. I told them something had struck the pilot house very close to my head. A piece of the cross timbers of the bridge, on which the flooring rests, a little over 2 feet long, which bears the marks of having been struck by a chimney and torn off, was shortly afterwards found on the hurricane deck near the pilot-house. All the guys of the larboard chimney, except one, were broken; and the hinge of the chimney was also broken to pieces, and that chimney hung quartering over the pilot-house nearly over my head. When I saw the chimney sway over my head in that way, I was very badly frightened, but dared not leave my post. Two of the iron cross pieces between the chimneys, which stay them from swaying, were broken; and one of them broke through the hurricane deck and the cabin deck, and fell on to the lower guards of the main deck. It fell through the cabin where the passengers usually stand when we pass the bridge; but we had no passengers on board at that time, having been laying aground at Buffington. The piece of iron must have weighed 15 or 20 pounds, to have broken through the deck by its own weight in falling. There were many of the rings at the top of the chimneys, to which the guy rods were attached, that were broken. One of the chimneys was badly mashed in at the top. We had to take both chimneys down and repair them, and to put in new rings for the guy rods.—*John Ferguson, Pilot.*

Brilliant, Thursday Packet.

"The Brilliant was detained at Wheeling yesterday morning, Dec. 18, 1849, by the obstruction to her passage caused by the bridge. The stage of water when we reached Wheeling, was about 24 feet. We were detained there between three and four hours. We were compelled to cut off 4 feet from each of our chimneys. The water was still rising. We were very near having to cut off an additional portion of our chimneys, from the rapid

rise of the river. We had very little to spare, after cutting off 4 feet. We did not clear the bridge by more than 3 or 4 inches."

* * * * * * * * * * * *

"On this last trip, we lost some fifteen to twenty passengers at Wheeling, that would otherwise have come on to Pittsburgh. At this season, there are not many passengers travelling; such an interruption occurring with our customary number of passengers, would cost us fifty or sixty passengers. * * I have learned from passengers that the liability to be stopped by the bridge, has been held out as an inducement to passengers to go by stage from Brownsville to Wheeling, instead of coming on to Pittsburgh and going down the river, as they had intended to do."

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"I consider 24 feet a very common stage of water, during the season of the year at which packets usually run."—*Capt. Redmond Grace. Original Record*, 208.

Clipper, Friday Packet.

She was obstructed on her downward trip, in February, from Pittsburgh to Cincinnati. I think there was at Wheeling 31 feet 4 inches of water at the time the boat reached the bridge. The water covered the register marks at Wheeling at the time; and that is as near a calculation as I can make. I left Pittsburgh at a quarter before 11 o'clock on Friday morning; the river at Pittsburgh was falling at the time. *In endeavoring to reach Wheeling before night, to effect a passage under the bridge, or to cut my chimneys off before dark, I refused to take freight at Wellsville or Steubenville, in order that I might be at the bridge before dark.* I arrived at Wheeling about 4 o'clock in the afternoon—rounded to above the bridge—made a line fast to the shore—dropped down to the bridge stem foremost, for the purpose of using the bridge to cut off my chimneys. After making the necessary preparations for cutting off the chimneys, by making a sling to lower a man away from the bridge to the chimneys, with a cold chisel and hammer, I took my crew and went on to the bridge by going ashore. After arriving on the bridge, I was accosted by the toll keeper. He asked me if I was captain of the Clipper; I told him I was. He said he was requested to say to me, by the President of the Bridge Company, that I could not make a convenience of the bridge for cutting off chimneys, as it was not built for that purpose. I then called my crew from the bridge and returned to the boat, and erected derricks and ladders, cut off my chimneys 4 feet, and passed under the bridge about 8½ o'clock that evening. I found that I had been deceived a little in cutting off my chimneys; they caught, in passing under the bridge, (some of the tie-bolts,) and came very near being

pulled down; so nearly so, that it was difficult to keep them up in any ordinary wind, they were so much loosened: and they finally did go overboard three weeks afterwards, in a gale of wind at Cincinnati, and I had to get new ones.—*Prescott Devol*, 56.

Messenger, Saturday Packet.

"I left the port of Pittsburgh, on Saturday the 10th day of November. inst. with the Messenger. The stage of water, when I left, was about 17½ feet by the marks. I arrived at the Wheeling Suspension Bridge about 7 o'clock, just after dark. The stage of water there was about 21 feet. I was not able to pass the bridge. We cut our chimneys off; about 7 feet of them—6½ or 7. * * * After we cut them off, we cleared the bridge by about 7 inches. The river was still rising. It was accompanied with a great deal of danger and trouble. It was a very troublesome job, delaying the boat about seven hours.—*Capt. Isaac C. Woodward. Orig. Rec.* 206.

Question. Are you now the mate of the steam boat Messenger, No. 2?

Answer. Yes; and have been since last September.

Question. How often has she been stopped by the Wheeling Bridge?

Answer. Twice.

Question. How did she get through?

Answer. We cut off a piece of her chimney each time.

Question. How many feet the first time?

Answer. About 7½ feet; and about 6 feet the second time.

Question. How long was she detained at the bridge the second time?

Answer. About 7 hours.

Question. Was it in the day time or at night?

Answer. We landed there before dark the last time; the first time in the night. We were going down the first time, and the next time coming up. The height of the water was about 28 feet the last time.

Question. What kept you there so long the last time?

Answer. We had to lie there two hours, before we could get permission to work on the bridge. The toll keeper said he was instructed not to permit us to use the bridge as a staging.—*John Erwin. Walworth's Rep.* 90.

Buckeye State, Sunday Packet. (61, 62, 655.)

I think it was on her fourth trip, one of her chimneys came in contact with one of the cross timbers of the bridge, and materially bruised and injured it by jamming the chimney, and injured her draft considerably. It knocked in the top of one side of the chimney. It was a down trip, and in the day-time.

Question. Under what part of the bridge was the boat passing at the time?

Answer. Under the highest part of the bridge. This was on Sunday evening, on her fourth trip, somewhere about the 10th of March. She is provided with the Telegraph No. 2 method of lowering her chimneys. We lowered our chimneys, as we supposed, to go under the bridge, but it turned out that the chimneys were not lowered sufficiently. She has lowered them four times, and was detained at one time three hours. When we had lowered our chimneys, the staging placed across the pilot house, for the chimneys to rest on when they were lowered, gave way, and disarranged our machinery for raising and lowering our chimneys, so as to cause the detention.

Describe the manner in which the Buckeye State passed the bridge the 9th of December, and the time it occupied in preparing to pass the bridge, in lowering two chimneys, passing the bridge, raising them afterwards, and in securing them in their places?

Answer. They commenced putting the derricks to their places, and getting the rigging ready to lower the chimneys, at least 20 miles above the bridge. They allowed the fires to burn down clean, so that there would not be much smoke from them when she arrived at the bridge. When we got near the bridge the boat was rounded to and landed above the bridge, at a quarter before 5 o'clock. She was 60 or 70 yards above the bridge, and was made fast to the shore on the Wheeling side. The chimneys were then lowered back as far as they could get them. She was then dropped down through the bridge, stern foremost, and was landed at the usual landing at Wheeling. The top of the larboard chimney fell off at the Wheeling wharf, before they began to raise the chimneys. It fell on to the sky-light, and crushed the edge of it down and rolled over on to the hurricane deck. The piece that fell off was three rings in length. They then took three rings off from the top of the starboard chimney, so as to make both chimneys of the same length, before we raised them. Then they raised the chimneys, and made all fast, 20 minutes after 8 o'clock in the evening. The whole time occupied in lowering and raising her chimneys, after she was landed above the bridge, until her chimneys were raised and made fast in their places again, was 3 hours and 35 minutes. There were as many as 30 men engaged in the operation. The three top rings of the chimneys were not riveted on, but slipped in. They had been injured the Sunday before by striking the bridge, so that they were loosened. The top of one of them was dinged in, and the band at the top of the chimney broken. At the time the top of the chimney was thus broken, one of the bolts which projected below the flooring and timbers of the bridge, was broken off, so that it fell on deck. I was only a passenger on the boat, but being an engine builder, I assisted in the operation of lowering and raising the chimneys.

The Pacific, New Orleans and St. Louis Packet. (41, 42.)

I took the Pacific down, as one of the pilots, about the 10th of June, 1850. She was built at Pittsburgh, for the St. Louis and New Orleans trade. The stage of water at the Wheeling bridge, when she reached there, was about 6 feet, as it appeared from the register in front of the U. S. Hotel. There was four and a half feet of water in the channel at Pittsburgh when we left, according to the pier marks at the Monongahela bridge. We had no obstructions till we got to the Wheeling bridge, and there we were detained in lowering the tops of her chimneys, from $2\frac{1}{4}$ to $2\frac{1}{2}$ hours, from the time we rounded to until we left the bridge, after her chimneys were up again. We had to round to above the bridge, and get a line out to the Virginia shore, and drop down gradually to the bridge, to ascertain how much it wanted for the chimneys to pass under the bridge. We wanted to see if we could pass under without lowering. We found, when we got to the bridge, that the chimneys lacked about 3 feet of being short enough to go under. We then got upon the bridge, and run a plank from the bridge to the top of the chimneys, which was about 10 feet from the bridge. Then the mate went out and made fast with a line around the top of the chimneys. By this time we pulled the chimneys back, and lowered them down, so that we could get under. We pursued this course with each chimney. Then we dropped under the bridge, and after we got to the lower side of the bridge, we raised the chimneys up again with the same line that we lowered them by.

Question. If you had had no hinges in your chimneys, how long, in your opinion, would it have required to take down your chimneys and replace them, so that the boat could proceed on her voyage?

Answer. It would, in my opinion, have required the largest part of two days.

Question. In that stage of water, what would be the probable consequence of that detention?

Answer. It would be hard for me to tell. The water was falling very fast, and the probability is, she would not have been able to put out from there until there had been another rise. If she had been detained two days, and had taken in the same amount of freight which she took in at Wheeling, she could not have gotten out in that stage of the water.

Question. Are boats of her class, in the New Orleans and St. Louis trade, usually provided with hinges to their chimneys?

Answer. I never saw a boat, of over 184 feet keel or more, that was prepared for lowering her chimneys, before the erection of the bridge.

APPENDIX.

STATE LEGISLATION AS TO BRIDGES OVER THE OHIO AND MISSISSIPPI RIVERS.

VIRGINIA.

The Act incorporating the Wheeling Suspension Bridge, passed March 19th, 1847, provides, in the 14th Section—

"If the said bridge shall be so erected as to obstruct the navigation of the Ohio River in the usual manner by such steam boats and other crafts as are now commonly accustomed to navigate the same when the river shall be as high as the highest floods therein heretofore known, then unless, upon such obstruction being found to exist, such obstruction shall be immediately removed or remodelled, the said last mentioned bridge may be treated as a public nuisance, and abated accordingly."

KENTUCKY.

The Act to authorize a bridge over the Ohio at the Falls, passed December 23, 1831, provides, in the 9th Section—

"That the said permanent bridge shall be erected so as to permit the passage of ships, schooners, sloops, and steam vessels, of the *largest size and height*, at the *highest* stage of water in the river."

SEC. 18. "The Legislature reserves the right to amend the charter so as to secure the navigation free from any injury."

The Act authorizing the erection of a bridge between Cincinnati and Covington, passed 17th February, 1846, provides—

"That nothing contained in this Act shall be so construed as to authorize the said Company to construct any bridge which may obstruct the free and common navigation of the said river Ohio." *Sec.* 13.

The Act authorizing the erection of a bridge across the Ohio River at Louisville, passed December 9th, 1850, provides—

"That nothing contained in this Act shall be so construed as to authorize said Company to construct any bridge which may obstruct the free and common navigation of the said river Ohio." *See.* 19.

OHIO.

The Act authorizing a bridge over the Ohio River at Wheeling, sanctioned and reënacted by the General Assembly of Ohio, provides—

"That if the said bridge shall be so constructed as to injure the navigation of the said river, the said bridge shall be treated as a public nuisance, and shall be liable to abatement upon the same principles and in the same manner as other public nuisances are." *Act passed Dec.* 30, 1816, *Sec.* 19.

An Act authorizing a bridge between Cincinnati and Covington, passed March 9, 1849, provides—

"That nothing contained in this Act shall be so construed as to authorize said Company to construct any bridge which may obstruct the free and common navigation of said river Ohio." *Sec.* 13.

The Act to incorporate the Steubenville and Indiana Rail Road Company, passed February 24th, 1848, provides—

"SEC. 2. And said Company is further authorized, with the consent of the Legislature of Virginia, or by arrangement with any company that may have authority from said State, to construct a bridge or viaduct across the Ohio River at Steubenville, so as to connect said road with a road leading eastward from that place, *provided that said bridge or viaduct shall be so constructed as not to interfere with the navigation of said river.*"

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INDIANA.

The Act authorizing a bridge at the Falls, passed January 26th, 1832, provides—

"That the said permanent bridge shall be erected so as to permit the passage of ships, schooners, sloops, and steam vessels of the *largest size and height*, at the *highest* stage of water in the river." *Sec.* 9.

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ILLINOIS.

The Act to incorporate the "St. Louis and Illinois Wire Suspension Bridge Company, passed February 18th, 1849, provides—

"When erected said bridge shall not obstruct or impede the free navigation of the Mississippi River for any ship, steam boat, or other water craft. *Provided*, That if any obstruction is caused by the erection of said bridge to any ship, steam boat, or other water craft, the said Company shall *forfeit their charter*, and pay all damages that may be sustained by any person or persons by reason of said obstruction." *Sec.* 7.

MISSOURI.

The Act authorizing the "St. Louis and Illinois Wire Suspension Bridge" is also ratified by the Missouri Legislature, with the provision that—

"Said bridge shall not obstruct or impede the *free* navigation of the Missouri River for any ship, steam boat, or other water craft," with provision that causing such obstruction shall forfeit the charter and subject the Company to payment of damages. *Sec.* 7.

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PENNSYLVANIA.

When the Bill to authorize a bridge over the Ohio at Wheeling, was pending before Congress in 1843–44, the following joint resolutions were passed, and being laid before Congress, the bill was defeated:

"*Whereas*, Application has been made to Congress of the United States, for an appropriation to aid in the erection of a bridge across the Ohio river at Wheeling, Virginia, the construction of which might materially obstruct the free use and navigation of said river above that point, and injuriously affect the commerce of the city of Pittsburgh, and all that district of Pennsylvania lying west of the Allegheny mountains, by arresting the building of war steamers, and other vessels of the great western manufacturing and commercial emporium of this State, by placing a barrier to their passage to the Gulf of Mexico, besides seriously interfering with the free navigation of the Ohio River by steam boats and other vessels engaged in the trade of the Western and Southern States, during high stages of water; therefore

Resolved, by the Senate and House of Representatives of the Common wealth of Pennsylvania, in General Assembly met, That our Senators in Congress are hereby instructed, and our Representatives requested, to vote against any appropriation by the National Legislature to the object above stated, and *oppose* every proposition for the erection of a bridge at Wheeling, or at any other point on the Ohio river, or any project that would result in increasing the obstacles already existing to the free navigation and use of that great thoroughfare of this commonwealth.

Resolved, That the Governor be requested to transmit a copy of the foregoing preamble and resolution to each member of the Pennsylvania delegation in Congress.

JAMES ROSS SNOWDEN,
Speaker of the House of Representatives.

WILLIAM BIGLER,
Speaker of the Senate.

Approved 26th January, 1844. DAVID R. PORTER.

The following resolutions were unanimously adopted by both branches of the Pennsylvania Legislature, in January, 1850:

"*Whereas*, The navigation of the Ohio River has been, and is now obstructed by bridges erected across its channel, between Zane's island and the main Virginia and Ohio shores, so that steam boats and other water craft hitherto accustomed to navigate said river are hindered in their passage to and from the port of Pittsburgh, and other ports in the State of Pennsylvania, and the trade, commerce and business of citizens of this Commonwealth interrupted, the revenue of her public works diminished and impaired, and steam boats owned and navigated by citizens of this State, bound to and from her ports, are subjected to labor, expense and delay, with hazard to life and property, by reason whereof the said bridges are a common and public nuisance, injurious to the State of Pennsylvania and her citizens; therefore, be it resolved, &c.

"1. That the free and uninterrupted navigation of the Ohio River as a common highway, is a right belonging to the citizens of Pennsylvania, which being essential to the prosperity of the State, it is the duty of the Commonwealth to assert and defend.

"2. That the proceedings in behalf of said State, instituted by her Attorney General in the Supreme Court of the United States, and now pending therein, against the Wheeling and Belmont Bridge Company, to abate the nuisance occasioned by their bridge lately erected across said river, be prosecuted to final judgment, decree and execution for abatement of said nuisance."

LEGISLATION BY CONGRESS IN RESPECT TO NAVIGATION OF THE OHIO.

On the 12th day of May, 1786, on the motion of Mr. Grayson, of Virginia, the following resolution was adopted:

"*Resolved*, That the navigable waters leading into the Mississippi and St. Lawrence, and the carrying places between the same, be and they are hereby declared to be common highways, and be forever free, as well to the inhabitants of said territory as to the citizens of the United States and those of any other States that may be admitted into the confederation, without any tax, impost, or duty therefor." *Jour. of Congress*, 1786. 637.

The Bill in relation to a bridge over the Ohio at Wheeling, introduced by the Committee on Roads and Canals, and defeated after the remonstrance of Pennsylvania, provided—

"That the bridge shall be so constructed as to admit at *all* times, without obstruction or delay, the safe and easy passage of steam boats of the largest dimensions." *House Bills*, 28*th Congress*, 1*st Session*.

COMPACT BETWEEN THE STATES IN RELATION TO THE NAVIGATION OF THE OHIO RIVER.

In 1789, Virginia being in possession of a large territory northeast of the Ohio, now constituting the State of Kentucky, desired to have it admitted into the Union as a separate and independant State. For this purpose her General Assembly, on the 18th December, 1789, passed an act providing for its erection as an independant State upon certain terms and conditions, among which were the following:

"*That the use and navigation of the river Ohio, so far as the territory of the proposed State, or the territory that shall remain within the limits of this Commonwealth lies thereon, shall be free and common to the citizens of the United States.*"—Virginia Rev. Code, 1819, p. 59.

To this Act the assent of Congress was given, (1. *U. S. stat. at large*, 64,) and it became a compact between Virginia and Kentucky with the other States of the Union.

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NEW YORK LEGISLATION IN RESPECT TO NAVIGATION.

The Legislature of New York required the Croton Aqueduct to be elevated 100 feet above the high water of the Harlem River.

"*An Act prescribing the manner in which the Croton Aqueduct shall pass the Harlem River. Passed, May* 3, 1839.

"The People of the State of New York, represented in Senate and Assembly, do enact as follows:

"SEC. 1. The Water Commissioners of the city of New York shall construct an aqueduct over the Harlem River, with arches and piers; the arches in the channel of said river shall be at least eighty feet span, and not less than *one hundred feet from the usual high water mark* of the river to the under side of the arches at the crown. Or they may carry the water across said river by a tunnel under the channel of the river, the top of which tunnel shall not be above the present bed of the said channel."

Upon the application for a bridge over the Hudson at Albany, the matter was at two sessions of the Legislature referred to a committee, and much testimony taken as to the effect of bridges upon the territory above them. After full enquiry, the application was rejected, on the ground that all bridges were injurious to navigation. *Report on Hudson Bridge, No.* 200, 1841. *Report on Hudson Bridge, No.* 198, 1845..